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Materials in Design Engineering

FORMERLY
MATERIALS
& METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES

16
Winning Entries
"Best Use of
Materials"
Competition

see page 127

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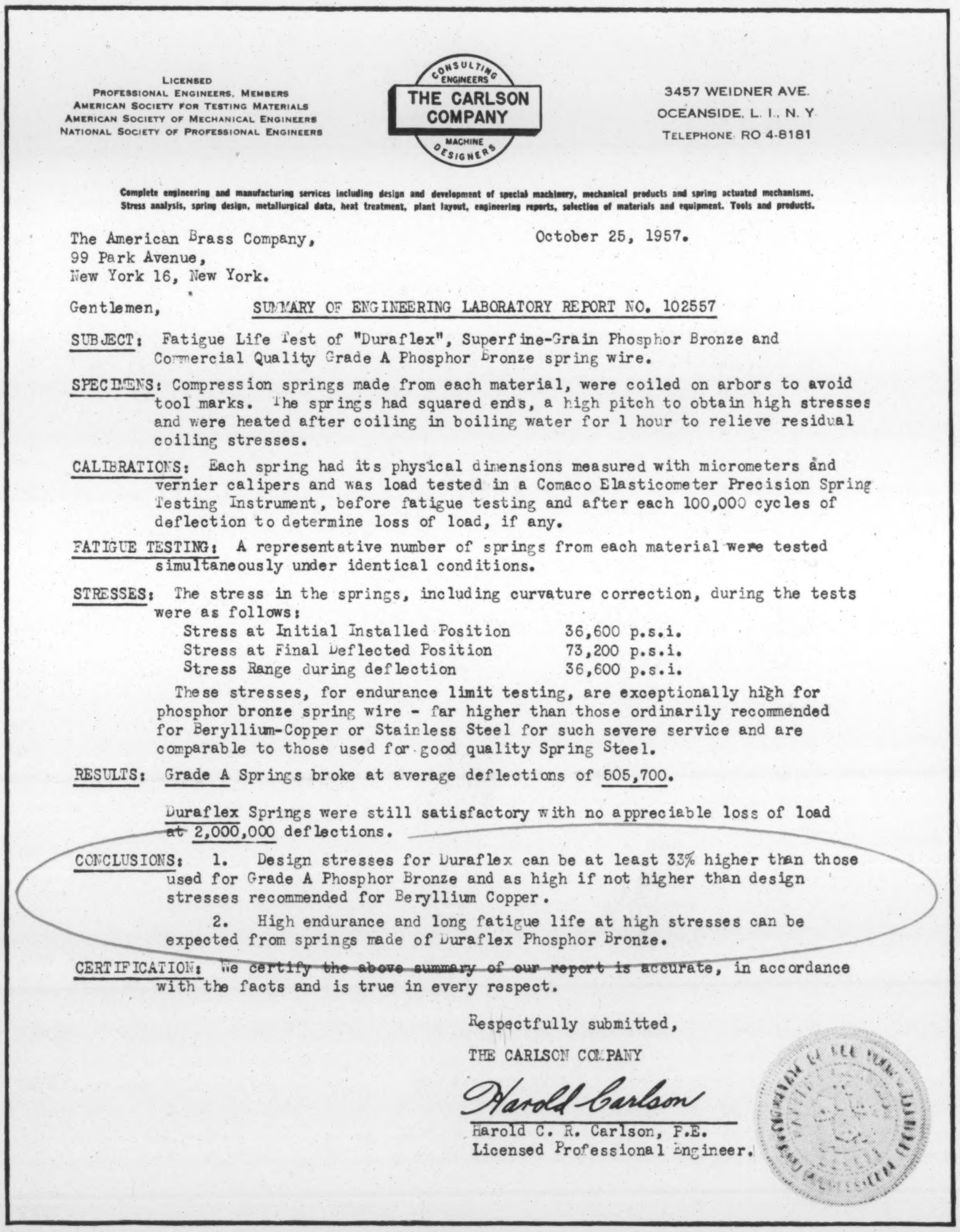
2,000,000 DEFLECTIONS WITHOUT FAILURE..... Severe fatigue tests show Duraflex,® Anaconda superfine-grain Phosphor Bronze, permits far higher design stress



LICENSED
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AMERICAN SOCIETY FOR TESTING MATERIALS
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CONSULTING ENGINEERS
THE CARLSON COMPANY
MACHINE DESIGNERS

3457 WEIDNER AVE.
OCEANSIDE, L. I., N. Y.
TELEPHONE RO 4-8181

Complete engineering and manufacturing services including design and development of special machinery, mechanical products and spring actuated mechanisms. Stress analysis, spring design, metallurgical data, heat treatment, plant layout, engineering reports, selection of materials and equipment. Tools and products.

The American Brass Company,
99 Park Avenue,
New York 16, New York.

October 25, 1957.

Gentlemen, SUMMARY OF ENGINEERING LABORATORY REPORT NO. 102557

SUBJECT: Fatigue Life Test of "Duraflex", Superfine-Grain Phosphor Bronze and Commercial Quality Grade A Phosphor Bronze spring wire.

SPECIMENS: Compression springs made from each material, were coiled on arbors to avoid tool marks. The springs had squared ends, a high pitch to obtain high stresses and were heated after coiling in boiling water for 1 hour to relieve residual coiling stresses.

CALIBRATIONS: Each spring had its physical dimensions measured with micrometers and vernier calipers and was load tested in a Comaco Elasticometer Precision Spring Testing Instrument, before fatigue testing and after each 100,000 cycles of deflection to determine loss of load, if any.

FATIGUE TESTING: A representative number of springs from each material were tested simultaneously under identical conditions.

STRESSES: The stress in the springs, including curvature correction, during the tests were as follows:

Stress at Initial Installed Position	36,600 p.s.i.
Stress at Final Deflected Position	73,200 p.s.i.
Stress Range during deflection	36,600 p.s.i.

These stresses, for endurance limit testing, are exceptionally high for phosphor bronze spring wire - far higher than those ordinarily recommended for Beryllium-Copper or Stainless Steel for such severe service and are comparable to those used for good quality Spring Steel.

RESULTS: Grade A Springs broke at average deflections of 505,700.

Duraflex Springs were still satisfactory with no appreciable loss of load at 2,000,000 deflections.

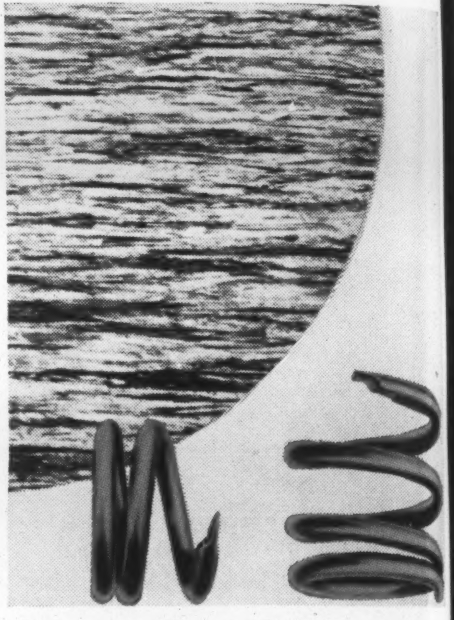
CONCLUSIONS: 1. Design stresses for Duraflex can be at least 33% higher than those used for Grade A Phosphor Bronze and as high if not higher than design stresses recommended for Beryllium Copper.

2. High endurance and long fatigue life at high stresses can be expected from springs made of Duraflex Phosphor Bronze.

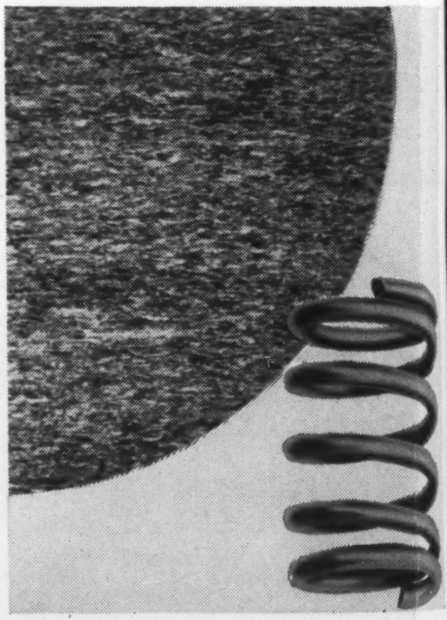
CERTIFICATION: We certify the above summary of our report is accurate, in accordance with the facts and is true in every respect.

Respectfully submitted,
THE CARLSON COMPANY

Harold Carlson
Harold C. R. Carlson, P.E.
Licensed Professional Engineer.



Spring of Alloy A Phosphor Bronze, shown actual size, which broke just after 500,000 deflections. Micrograph (75x) shows typical grain structure of this metal.



Spring of Duraflex showed no appreciable loss of load after 2,000,000 deflections in same test. Micrograph (75x) shows typical superfine-grain structure of Duraflex.

Duraflex is a registered trade-mark for a higher quality phosphor bronze in sheet and wire forms, recently developed by American Brass Company research. Yet it costs no more than regular phosphor bronze. For detailed information—for a copy of the test data—write The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5845

DURAFLEX

Superfine-Grain Phosphor Bronze
A product of

ANACONDA®

Made by The American Brass Company

For more information, turn to Reader Service card, circle No. 592

Materials

in Design Engineering® *formerly Materials & Methods*

Selection & use of metals, nonmetallics, forms, finishes

APRIL 1958
VOL. 47, NO. 4

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N. Y. Daily News Photo

New York's famous Coney Island boardwalk has undergone many changes in the last 35 years, but its old-time lampposts remain.

Corrosion-resisting Monel fastenings have held Coney Island lampposts securely for a generation.

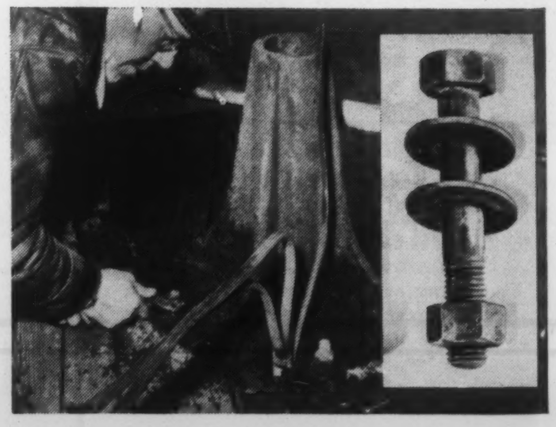
35 years in salt and storm throw light on a common fastening problem

One of the lampposts on Coney Island's boardwalk was taken down recently . . . Inside its base, a three-inch layer of rust flakes. Under the rust, four Monel* nickel-copper alloy bolts and nuts, holding the post tightly to the boards.

Threads were as clean and sharp as new. An easy twist with a pliers, and out came each Monel fastening — as fit as the day it had been put in! (see photo at right)

Salt corrosion is just one of the tough operating conditions Inco Nickel Alloy fastenings and other parts meet successfully. They do outstanding service under conditions of cyclic stress . . . high and low temperature . . . acid, alkaline attack. Selecting a metal to overcome conditions like these? Get Inco's handy guide — "Standard Alloys for Special Problems" — yours for the asking. *Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.



Bolt, nut, washers are still in excellent shape, little corroded after their long service.

INCO NICKEL ALLOYS

NICKEL ALLOYS PERFORM BETTER LONGER

For more information, turn to Reader Service card, circle No. 543

What's new IN MATERIALS

...AT A GLANCE

TEFLON WITH EXCEPTIONAL DIMENSIONAL STABILITY is now available in pilot plant quantities as rod, tape, tubing and molded parts. The TFE (polytetrafluoroethylene) resin is reinforced with a combination of inorganic reinforcing agents (composition of which has not been revealed). According to the producer, the reinforced material has better wear and creep resistance and retains its shape longer than other reinforced TFE compositions. Anticipated uses include gaskets, seals, valve seats, electrical insulation and piston rings. (More details next month.)

MORE HEAT RESISTANT STAINLESS STEEL AND MOLYBDENUM PARTS can be obtained by electroplating them with iridium. Tests show that the parts do not scale when exposed for 30 min at temperatures as high as 2400 F. The iridium electroplate is deposited on the metals by a new cyanide plating process.

A NEW ALUMINUM DIE CASTING ALLOY is now available for heavy bearing applications. The alloy withstands bearing loads of 1500 psi, and has a tensile strength of 36,000 psi and a yield strength of 20,000 psi. Anticipated uses include connecting rods for air conditioner and refrigerator compressors, gear housings for washing machines and dryers, and parts for electric hand tools.

IMPROVED ELECTRONIC DEVICES may come out of the development of extremely thin aluminum oxide films. The films are of particular interest in electronic devices because they have very high structural strength for their weight and can be used to support sensitive materials required in electronic imaging tubes. The films do not interrupt the flow of electrons; they are almost perfectly transparent and colorless; and they are relatively easy to make. (More details next month.)

A NEW POLYESTER FILM, DESIGNED ESPECIALLY FOR LAMINATING, has been introduced by a new company in the field. Now in limited production, it will mean more competition in certain areas for existing polyester films (Mylar, Scotchpac). The new film (Videne) is heat sealable and is said to adhere, under heat and pressure, to textiles, metals, wood, paper and certain plastics without adhesives. It is capable of being vacuum formed or drawn to the limits of supporting materials. Another version of the film is available for packaging applications. (More details next month.)

COBALT-BASE ALLOYS SEEM TO BE BEST FOR TURBINES and other hydraulic equipment that must withstand the damaging effects of cavitation, according to results of laboratory and field evaluation tests. Typical cobalt-base alloys contain from 40 to 80 cobalt, 20 to 35 chromium, 0 to 25 tungsten, 0.75 to 2.5 carbon and 0 to 3% silicon. The tests, conducted over a 35-year period, show that stainless steels and aluminum bronzes also have good resistance to cavitation, whereas mild steels, cast irons and cast steels generally have low resistance.

MOST EFFECTIVE THERMAL INSULATION YET DEVELOPED is the claim made by the manufacturer for a new family of insulations that is said to have lower thermal conductivities than still air. The insulations, described as ". . . bonded structures reinforced with fibrous media," are said to have good resistance to vibration and heat; one can be used for extended periods of time at temperatures up to 1300 F. They are particularly recommended as heat barriers in guided missiles and high speed aircraft. (More details next month.)

LESS EXPENSIVE CONTROL RODS FOR NUCLEAR REACTORS may come out of the development of a new silver-base alloy containing indium and cadmium. At present hafnium is used for control rods, but it is expensive and not too readily available. The new alloy, although not as good as hafnium in heat and corrosion resistance, is expected to last the life of the core.

BLACK POLYETHYLENE WITH IMPROVED OXIDATION RESISTANCE is promised with the use of several new antioxidants. Used in conjunction with carbon black, the antioxidants (substituted thioethers) are said to be ten times more effective in reducing both thermal and photo oxidation than presently used antioxidants; for example, they give protection for 2000 hr at 280 F in an oxygen atmosphere instead of the 200 hr usual with conventional antioxidants.

HARD-TO-FORM METALS CAN BE MADE TO CLOSE TOLERANCES with a new method of precision fabrication. High strength bronzes, tool steels, high alloy steels, and high temperature ferrous and nonferrous alloys are first investment cast to form a precision blank; the blank is then worked by coining and cold heading to produce a part with average dimensional tolerances of ±0.003 in. per in. The developer says the multiple fabrication method produces parts at lower costs than possible with a single fabrication method.

Turn to page 169 for more "What's New in Materials"

MATERIALS BRIEFS

Phantom Train

Buried copper wires guide a train around 90 deg-curves, across streets and through narrow aisles of a warehouse without the aid of a human operator. The train stops at each of four stations in the warehouse and toots its whistle for attention; if no one comes to unload within 2 min, it takes off for the next stop.

Footprints, Anyone?

The authentic footprint of a dinosaur preserved in a layer of stone for over 170 million years is now being duplicated in polystyrene on a mass production basis for museums and schools. The plastics footprint is vacuum cast from a production mold that was made from the original print in the stone.

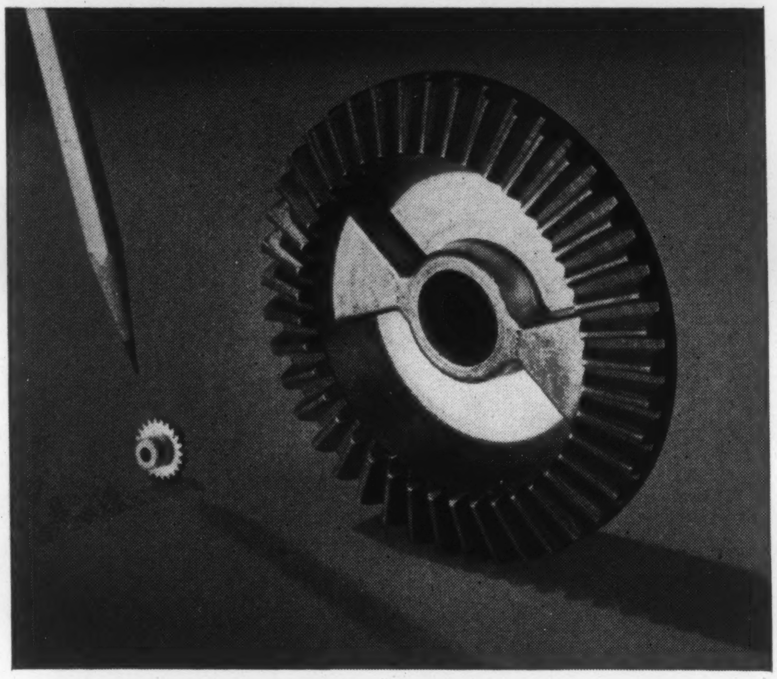
Smokeless Cooking

An aluminum cooking pan cover is now supplied with an electrical device that is said to eliminate objectionable cooking odors. The device, fitted in the center of the aluminum cover, employs an electrically heated wire to burn off smoke and grease.

Driving Blind

Ferrite rods used in an automobile collision warner may someday help drivers safely steer their automobiles through fog, rain, sleet and snow. The ferrite rod picks up radio signals reflected from the metallic surface of approaching vehicles and transmits the message to a unit on the dashboard which lights a large red light or sounds a buzzer, warning the driver of the other vehicle's approach.

HOW CAN BRASS POWDER METALLURGY HELP YOU?



BY CUTTING COSTS ....
INSTEAD OF CUTTING PARTS

This large transmission gear for a man-carrying power mower once cost $1.56 each as a machined sand casting. Now, as a stronger, brass-infiltrated powder metal part, it costs $1.10. — **A COST SAVING OF 29%**

As a machined part, the small brass gear once cost 16¢ each. Now made as a brass powder sintering, the cost is only 6¢. — **A COST SAVING OF 62½%**

A powder metal fabricator can show you how brass powder metallurgy can help your products the same way — and with many other advantages, too.

Facts about
PRESSED BRASS
and other nonferrous
POWDER PARTS

THIS BOOKLET
will assist you in evaluating this modern production method in terms of your particular needs.

◀ **SEND FOR YOUR COPY**

THE NEW JERSEY ZINC COMPANY
160 Front Street, New York 38, N. Y.

For more information, turn to Reader Service card, circle No. 399

More Weight in Less Space with Mallory 1000 Metal

WHATEVER the nature of your assembly—gyroscope rotors, counterbalances, balancing weights, or similar mass components—you can get more weight into less space with Mallory 1000 Metal.

Mallory 1000 has a density of 16.96 gm/cc—twice that of brass or steel, and is far stronger than lead! It features ready machineability—even to a high surface finish.

More weight in less space means real savings in several ways. For example, housings can be made smaller—thus overall assemblies become smaller for a savings in cost and weight. Mallory 1000 Metal provides exceptionally high inertia in a smaller space, increasing the sensitivity of gyroscopic or balancing action, yet reducing the overall unit size.

Complete information on Mallory 1000 Metal specifications and applications may be had on request. Write today.

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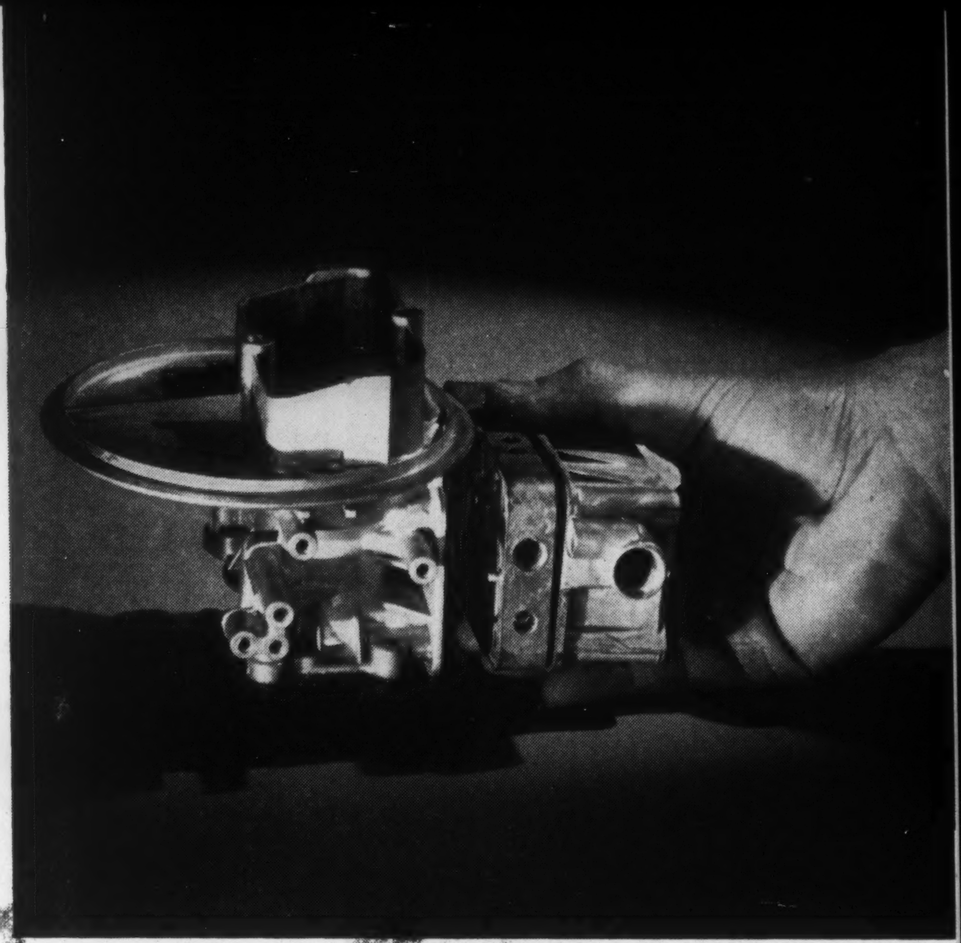
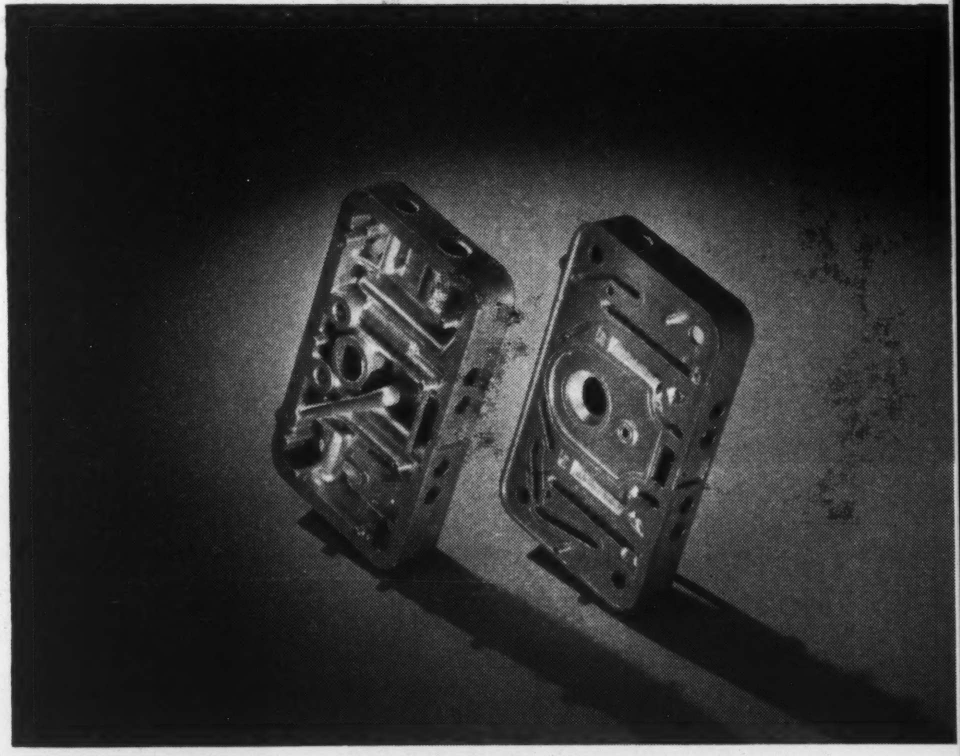
For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

For more information, turn to Reader Service card, circle No. 425

MATERIALS AT WORK

New and interesting applications of engineering materials

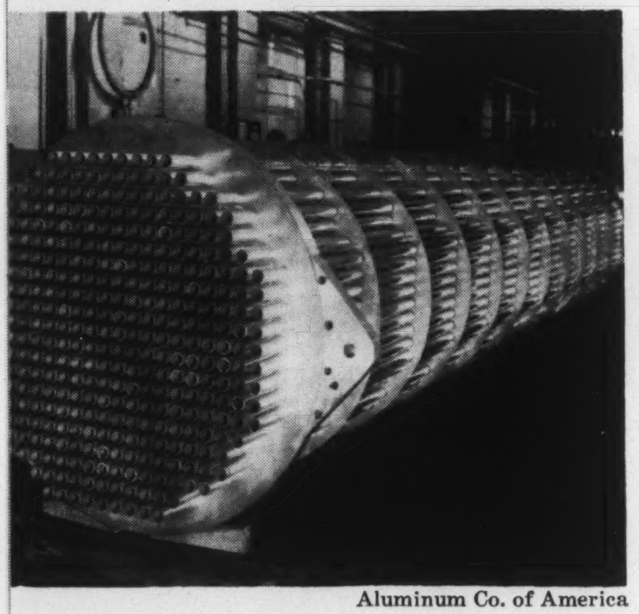




Complex zinc die castings improve carburetor design

The use of zinc die castings has resulted in substantial improvements in the design of a new carburetor for automobiles (see top photo). According to New Jersey Zinc Co., the new carburetor is not only more efficient and economical, but, because projections and openings are integrally cast, easier to assemble and install. In addition, maintenance and service have been reduced to a minimum.

The heart of the carburetor, the fuel metering body (see bottom photo), is a complex maze of cored holes, recesses, pins and grooves. Zinc was selected because it is a relatively inexpensive metal and because it can be easily cast to extremely close dimensional tolerances. The zinc parts are used virtually as cast, requiring practically no secondary operations.

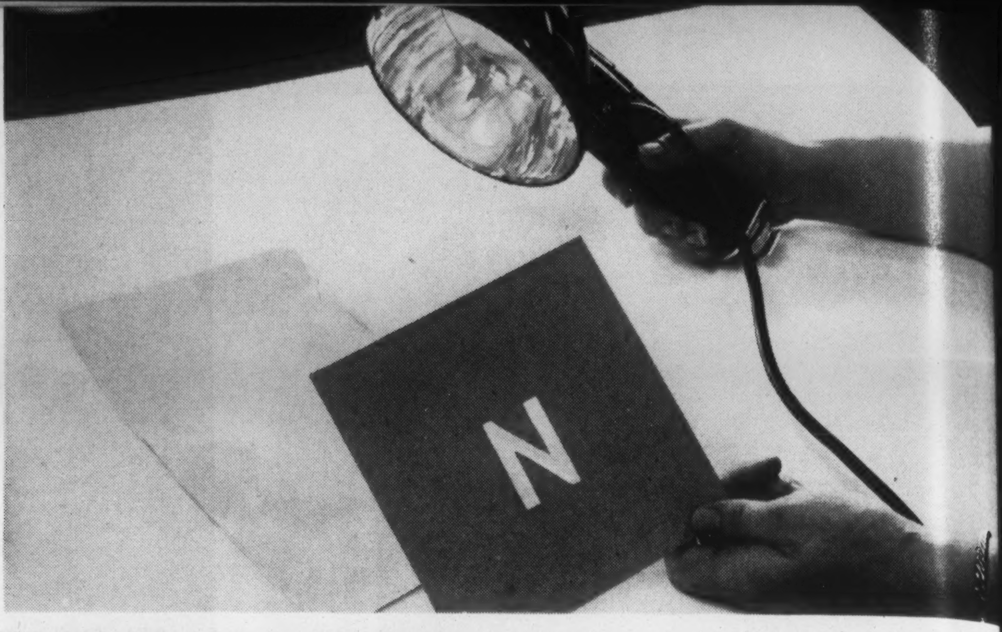


Aluminum Co. of America

Heat exchanger unit made of aluminum

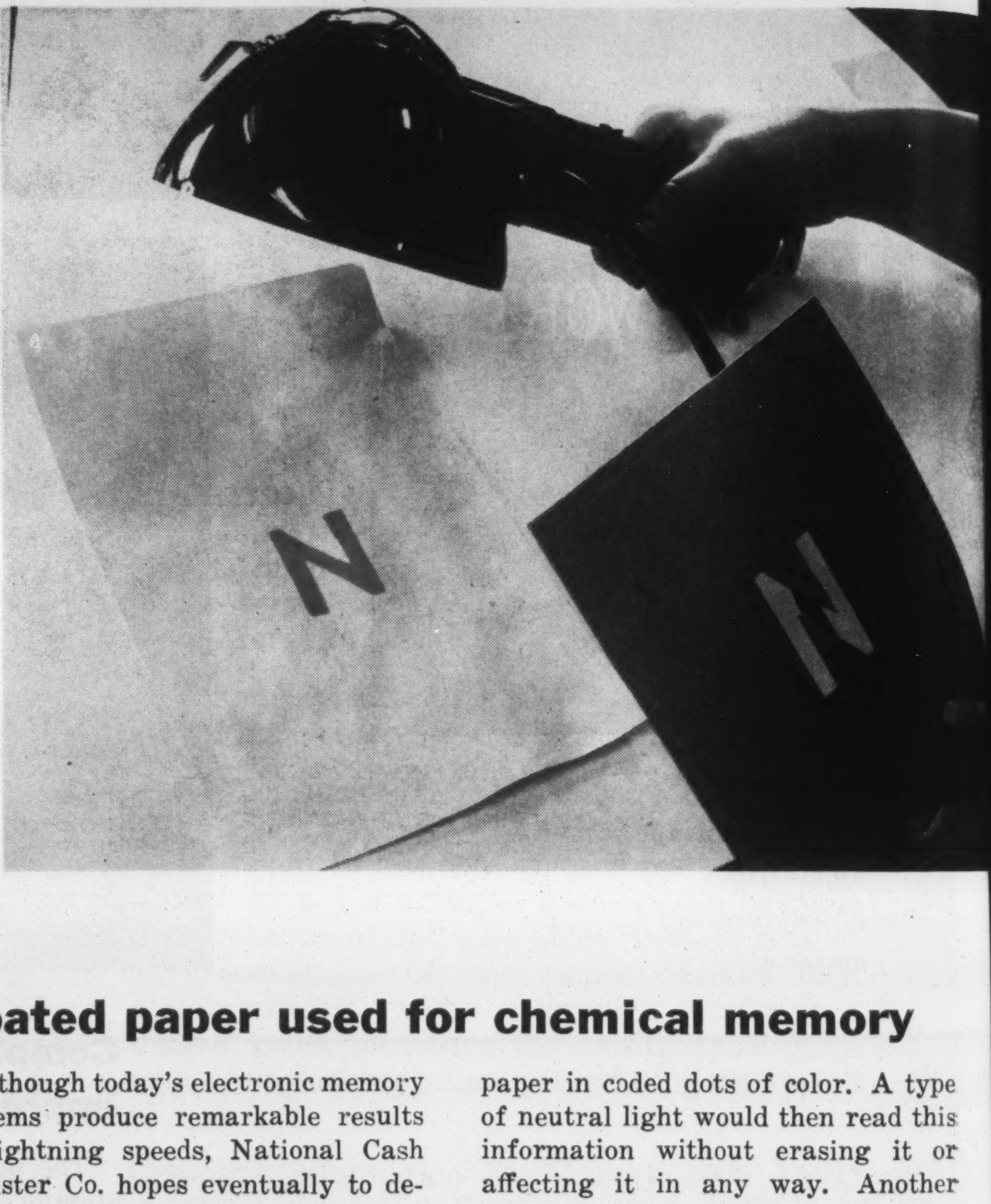
High thermal conductivity, light weight and corrosion resistance are the reasons given for the selection of aluminum for heat exchanger units used in the manufacture of nitrate fertilizers.

The unit, composed of a bundle of 365 aluminum tubes, weighs 11,000 lb, is 28 ft long, and is 49 in. in dia over the largest flange (see photo). The lugs on the fixed tube sheet are used to lift the bundle out of the aluminum shell.



Coated paper exposed to light . . .

. . . changes color to produce image.

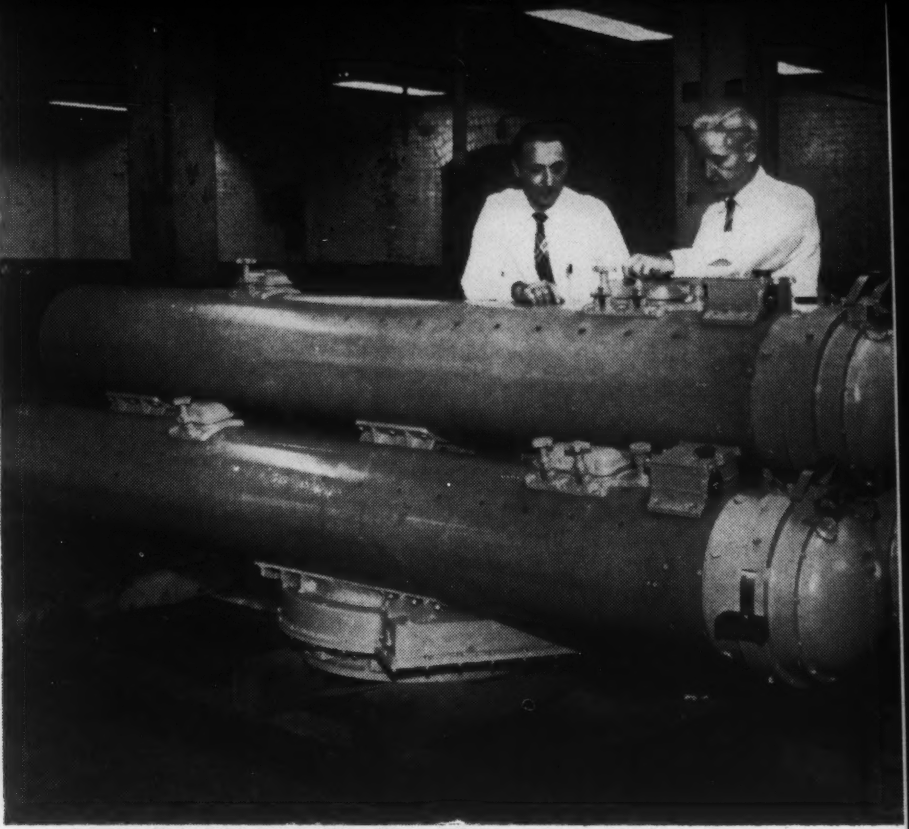


Coated paper used for chemical memory

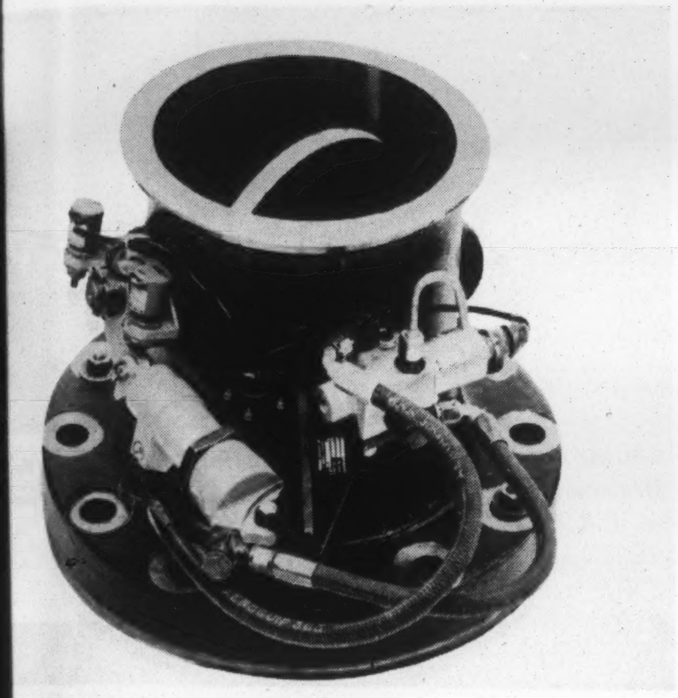
Although today's electronic memory systems produce remarkable results at lightning speeds, National Cash Register Co. hopes eventually to develop memories which operate at even higher speeds, yet cost less and have greater capacity for storing information. According to NCR, chemical-type memories offer most promise in this direction.

In essence, chemical-type memories would consist of paper coated with microscopic cells of a photochromic dye that change color when exposed to different wave lengths of light. An extremely narrow beam of light could be used to "write on" the paper in coded dots of color. A type of neutral light would then read this information without erasing it or affecting it in any way. Another type of light would erase the color pattern, returning the coating of capsules to its original state and thereby preparing it to receive further information at such time as the computing system designates.

According to the NCR scientists, ". . . chemical memory cells . . . could be made so tiny that millions of them could be placed on a 1-sq in. surface. Conceivably, the contents of an entire book could be placed on only a few sheets of ordinary size paper."

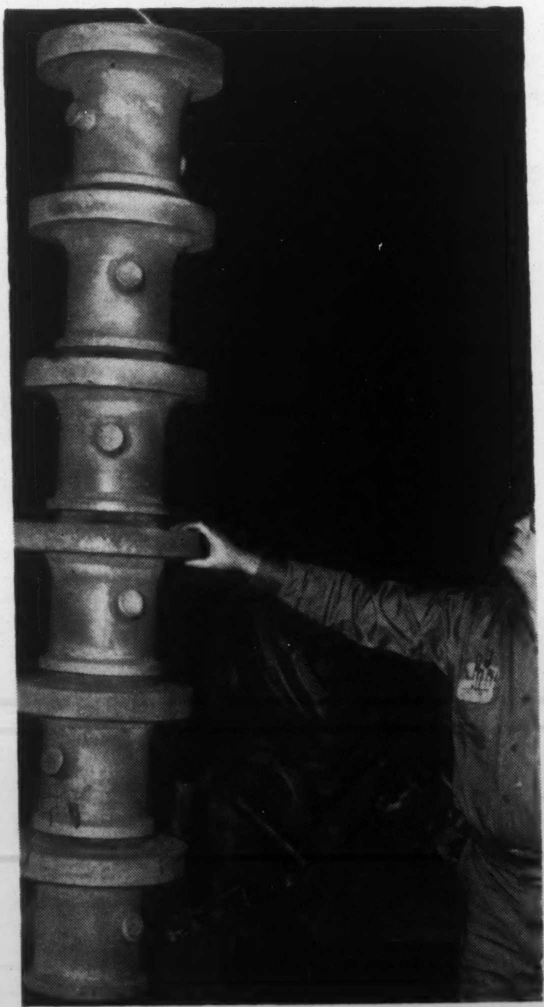


Apex Reinforced Plastics Div., White Sewing Machine Corp.



Stainless valves used with missiles are . . .

. . . centrifugally cast six at a time.



Alloy Casting Institute

Stainless casting replaces weldment

The switch from a weldment to cast stainless has resulted in a 30% cost saving in the production of valves (see photo) used with the Atlas intercontinental ballistic missile.

The original design, consisting of welded wrought stainless steel flanges and tubes, was unsatisfactory for several reasons: 1) machining and welding costs were high; 2) mechanical failure sometimes resulted from intergranular corrosion along the weld zones; and 3) the welded seams offered an opportunity for leakage.

To overcome these limitations, Interstate Engineering Corp. redesigned the 180-lb valve so that it could be centrifugally cast in one piece from Type CF-8 stainless (19 chromium-9 nickel-0.08% carbon max). As a result, costs were reduced, impact strength was increased, and gas leakage was eliminated. In addition, the valves can be cast six at a time (see photo).

Torpedo launcher of reinforced plastics

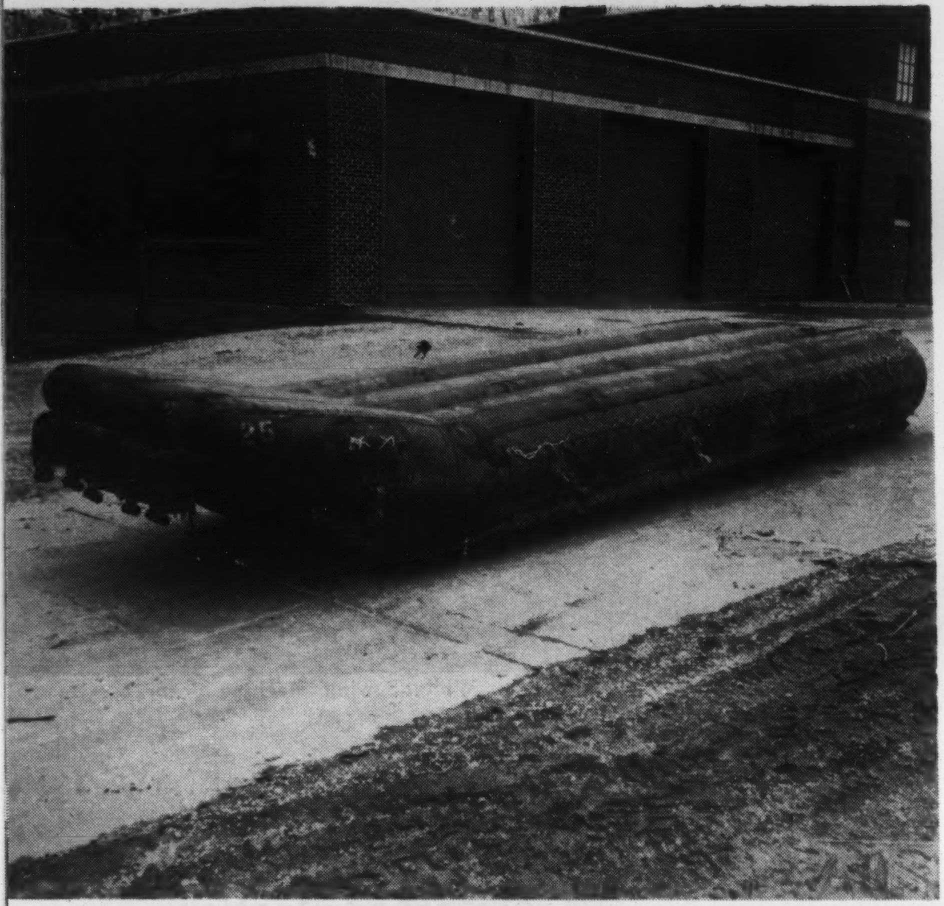
Glass-reinforced plastics have taken another step forward in their bid for acceptance in high pressure applications. The latest high pressure application is the torpedo launching assembly shown above. Main advantages derived from the use of this material are high strength at low weight (the entire assembly weighs 2000 lb; if made of steel, it would weigh about 4000 lb) and resistance to corrosion, especially from salt water.

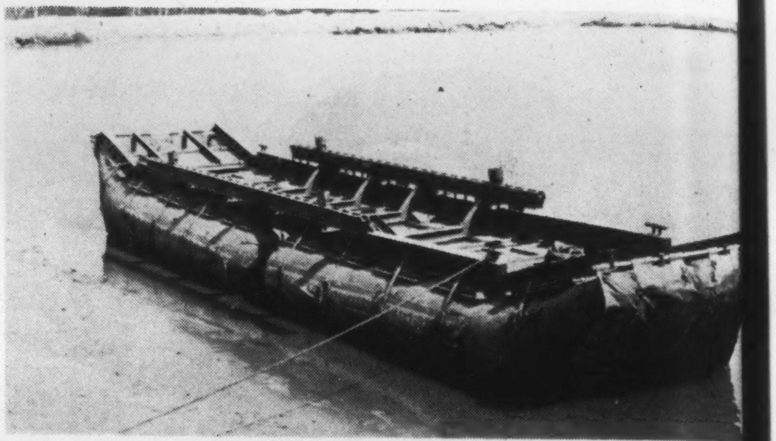
The launching assembly consists of three tubes, made entirely of glass mat-reinforced polyester resin, plus hardware and electrical equipment. Within the tubes are quadrants and adapters which permit the launcher to accommodate various size torpedos.

The basic tubes are centrifugally molded; the quadrants, adapters, covers and other small parts are compression molded. Three high pressure, filament-wound reinforced plastics bottles supply initial thrust for the torpedo, exerting pressures within the tube of from 3000 to 5000 psi.

MATERIALS

AT WORK



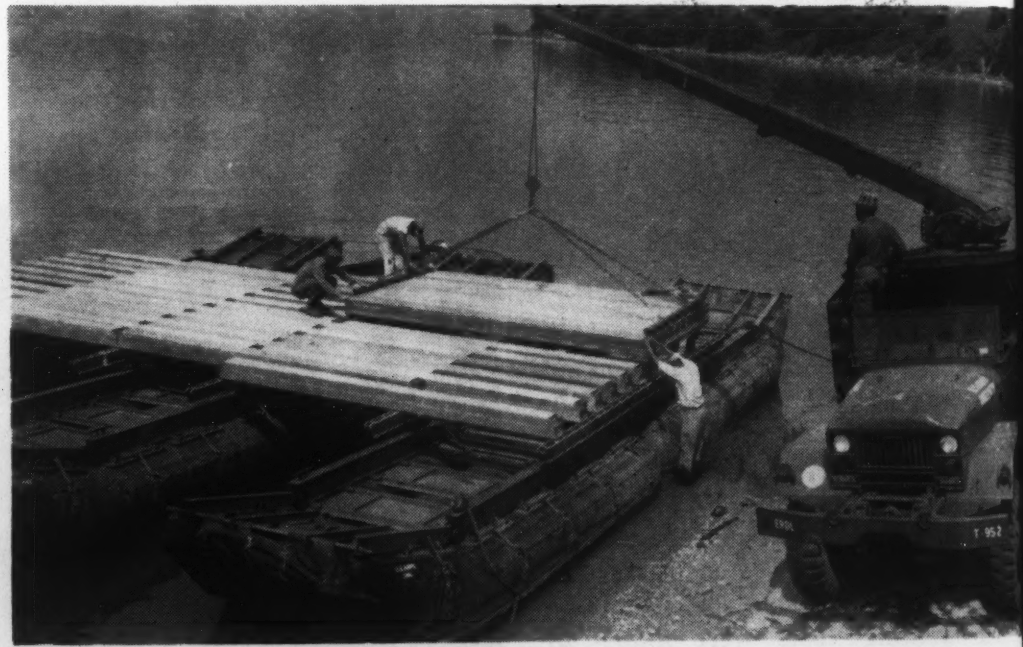


1—Basic unit of bridge *is this half float made of three neoprene coated nylon tubes, each 3 ft in dia and 22 ft long. Straps at ends are used to hold steel beams.*

2—Pneumatic half floats are joined *to form full float. Plywood panels and steel beams are used to provide stiffness and distribute the load.*

Variety of materials used in floating bridge

A hand-erectable floating bridge that can support 60-ton loads has been developed by the U. S. Army Engineer Research and Development Laboratories. The bridge, referred to as the M4T6, uses several lightweight components that can be transported by air; the heaviest single component is a 750-lb neoprene coated nylon float. Other materials used include hollow aluminum deck sections (225 lb each), steel beams and plywood panels. The bridge can be erected manually at speeds up to 1½ ft per min.



3—Hollow aluminum deck sections *are placed side by side in a staggered position to serve as a road surface.*

4—Completed bridge.

MORE MATERIALS AT WORK

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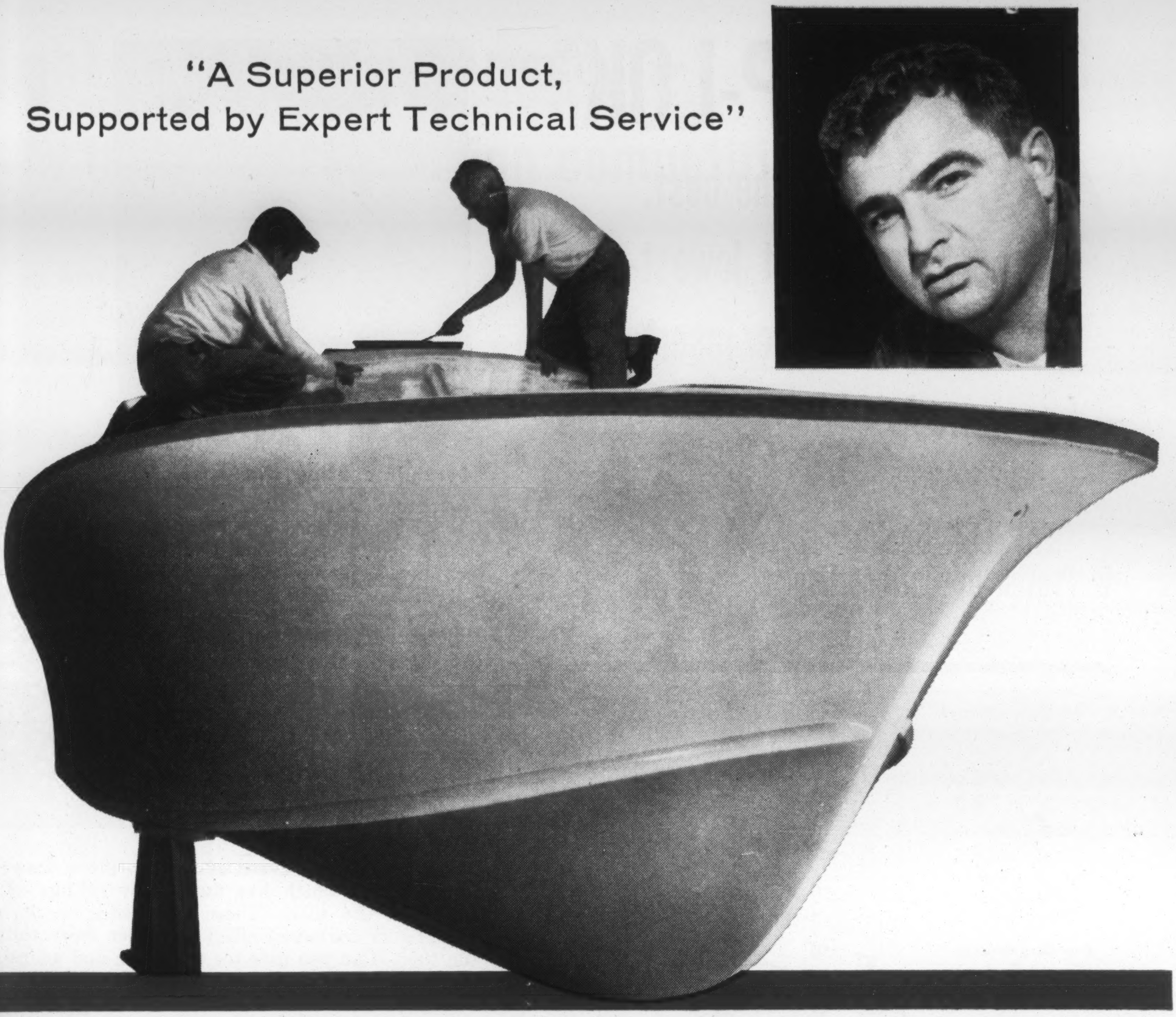
Huge steel spikes halt earth movement.... 232



"A Superior Product,
Supported by Expert Technical Service"

Why the American Hydroplane Corporation Chooses

RCI EPOTUF Epoxy Resins

"We listed the properties we wanted in epoxy materials, and RCI came up with a resin to fit our needs." Speaking is Robert Hobbs, president of the American Hydroplane Corporation, Coral Gables, Florida, an engineering firm specializing in the design and construction of custom and prototype boats.

An unusual case? Not at all. It merely demonstrates the kind of helpful cooperation that you, too, can expect from RCI...*plus* a resin that suits your requirements to perfection.

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Perhaps the several advantages of EPOTUF Epoxy Resins—their toughness, superior bonding, non-running after application—can help on one or more of *your* applications. Add to this two further "plusses"—expert technical assistance and fast delivery anywhere in the country—and you have ample reason for doing business with RCI.

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Letters
to the editor

Ceramic coating thickness

To the Editor:

Your published version of our article "Measuring Fracture of Ceramic Coatings," Feb '58, p 166, contains an error in Fig 1. The values of coating thickness should be multiplied by ten. Because these figures summarize the primary results obtained in our investigation, it is important that this correction be called to the attention of your readers.

D. R. WALKER and
H. H. WYATT
Avco Manufacturing Corp.
Lawrence, Mass.

Rifled tubing

To the Editor:

We recently learned of a steel tubing known as "turbo tube" which has flutings or riflings on the inside of the tube. These reportedly result in a swirling or turbulent effect as water flows through the tube. Can you give me the name and address of the manufacturer, or manufacturers, of this tubing?

E. C. BAST
Metallurgist
Atchison, Topeka and Santa Fe Railway Co.
Topeka, Kan.

We are not familiar with this tubing.

Vacuum-cast nickel alloy

To the Editor:

In the Feb '58 issue, an article entitled "Vacuum Cast Nickel Alloy vs 'Best' Cobalt Alloy" makes some comparisons between vacuum-cast Udimet 500 alloy and AMS-5382-B (Haynes Stellite alloy No. 31). We would like to call to your attention some errors which appear in the comparison chart on p 116.

The tensile properties listed for AMS-5382-B are those obtained at 1700 F, not 1200 F. At 1200 F, AMS-5382-B has an average as-cast tensile strength of 75,500 psi with an average reduction of area of 12.6%. Admittedly, Udimet 500 is a fine alloy but it is not three times stronger than AMS-5382-B, as stated in the article.

S. J. MCCRACKEN
Haynes Stellite Co.
New York, N. Y.

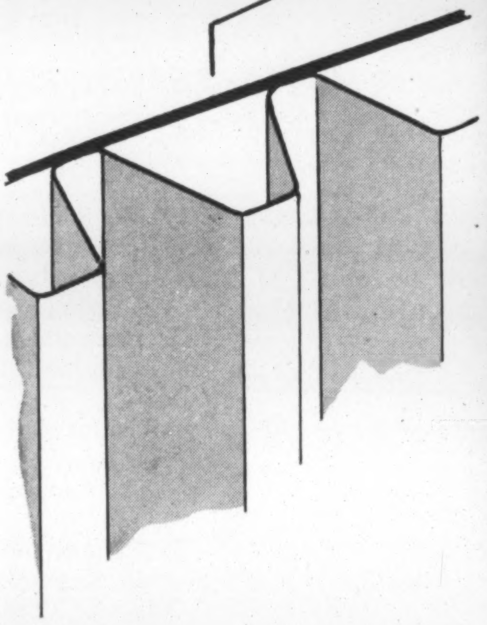
Small fusible cylinders

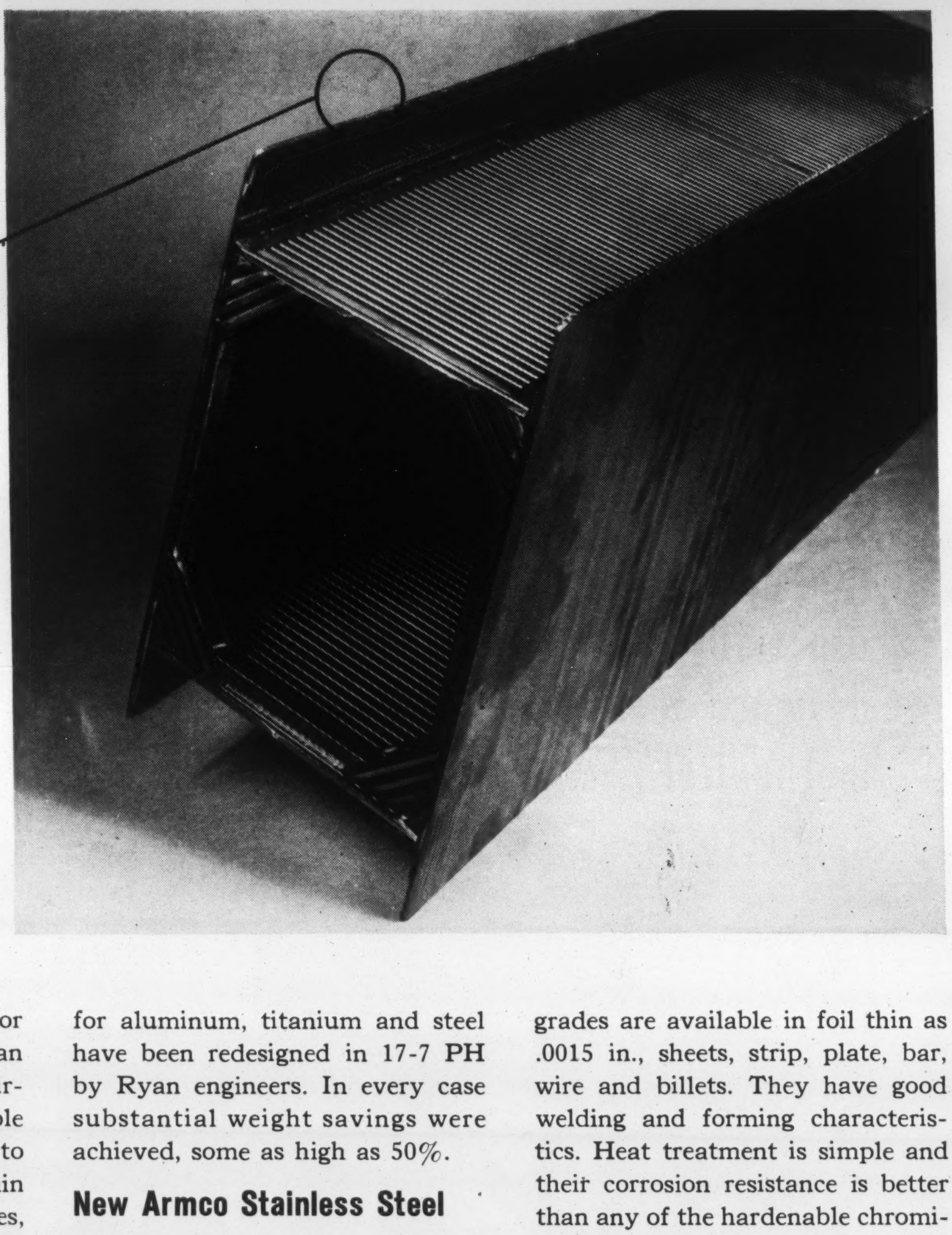
To the Editor:

This concerns a letter from W. D. Jones, Jan '58, p 16, in which he asks about a possible cold setting cement, fusible at less than 300 F, to be used to reproduce the shape of small cylinders. Although I have never tried it, I have often considered using

Light Structures of Armco 17-7 PH Stainless Steel win top award in design competition

Ryan Aeronautical Company awarded first place in M/DE competition for effective use of special high-strength stainless in weight-saving design.





A typical Miniwate structure—6″ x 8″ box beam—constructed entirely of 17-7 PH stainless steel.

Ryan's award-winning design for light-weight 17-7 PH structures can make supersonic missiles and aircraft up to 25% lighter, or capable of withstanding temperatures up to 750 F without weight penalty. Thin sheet and foil Miniwate structures, stabilized for high compression loads by miniature corrugations, not only exploit the 200,000 psi room temperature yield strength of 17-7 PH but also make efficient use of the material's excellent properties at elevated temperatures.

Many parts originally designed for aluminum, titanium and steel have been redesigned in 17-7 PH by Ryan engineers. In every case substantial weight savings were achieved, some as high as 50%.

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PH 15-7 Mo, Armco's newest precipitation hardening stainless steel, provides even higher strength-weight ratios at room and elevated temperatures than 17-7 PH. And it offers the same unique combination of advantages for industrial equipment, missiles and aircraft. Both grades are available in foil thin as .0015 in., sheets, strip, plate, bar, wire and billets. They have good welding and forming characteristics. Heat treatment is simple and their corrosion resistance is better than any of the hardenable chromium stainless grades.

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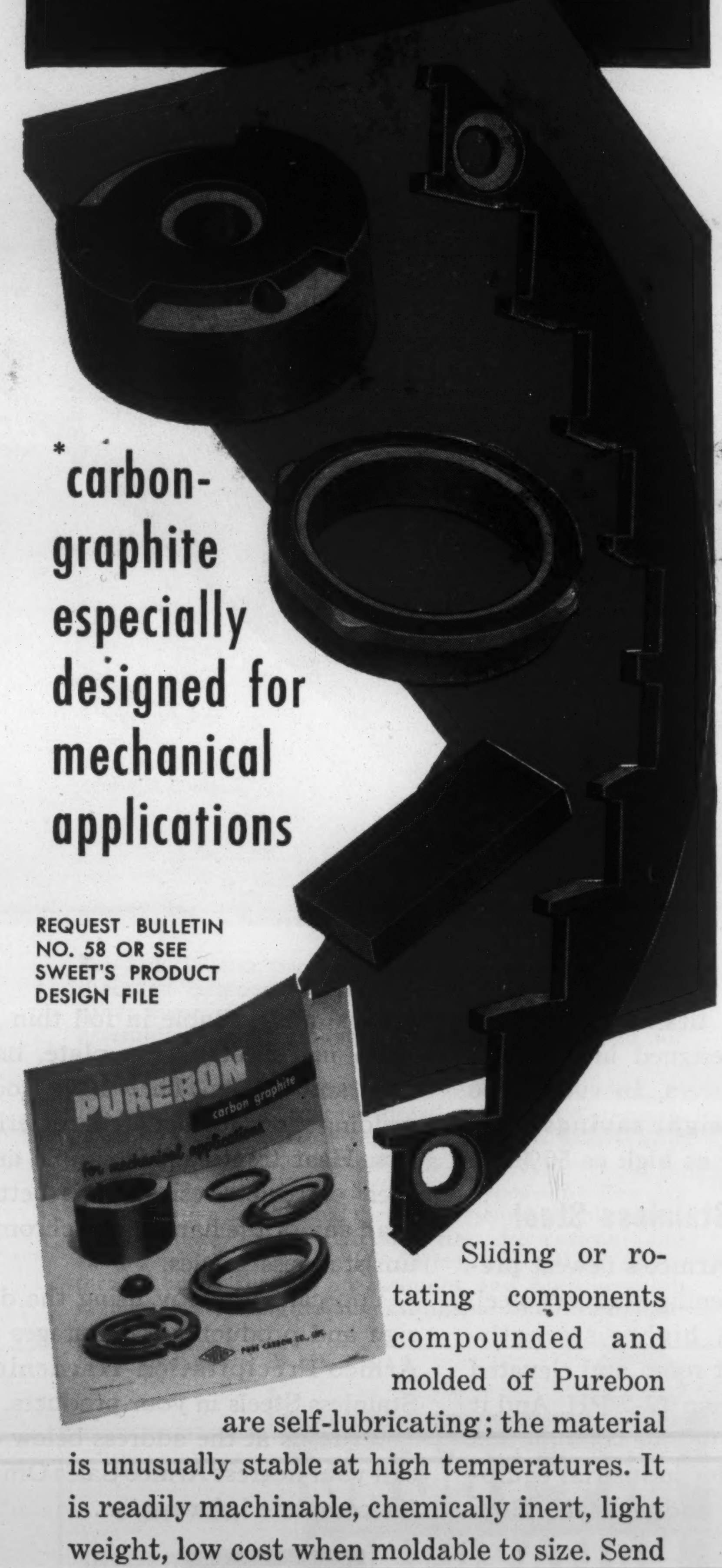

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For more information, turn to Reader Service card, circle No. 499

Letters to the editor

mercury-silver amalgams for this purpose. They are extremely stable dimensionally and are used by dentists for filling teeth.

For properties see *Physical Properties of Dental Materials*, Bureau of Standards Circular C433. This can be obtained from Supt. of Documents, Bureau of Standards, Washington 25, D. C.

JAMES D. THACKSEY
Pasadena, Calif.

To the Editor:

With reference to the letter by W. D. Jones, I would like to suggest that he investigate Cerro Alloys. There are a number of these with melting points ranging down to 117 F and with shrinkages that range from +0.0005 in. per in. (immediately after pouring) to −0.0002 in. per in. (stabilized, 5 hr after pouring).

These alloys are marketed in this country by Cerro de Pasco Sales Corp.; its British associates are Mining and Chemical Products Ltd., London, England.

K. R. SCHENDEL
Materials & Standards Engineer
Westinghouse Electric Corp.
Cheswick, Pa.

O-rings in severe service

To the Editor:

Two recent articles, "A Guide to Synthetic Rubbers," Sept '57, and "The Fluoro-Elastomers," July '57, contained very interesting information. We are particularly interested in the elastomer Viton A. A research project we are currently working on requires the use of o-rings and a quart capacity oval rubber bladder in wells producing petroleum. The aromatic hydrocarbon content in some of these wells may run as high as 10%, and temperatures up to 250 F.

To date we have been unable to secure o-rings whose swelling in this environment was low enough to prevent seizure of mechanical seals. Also, we have been unable to find a suitable material for the rubber bladder in this environment. We think that our bladder design may be adequate if made of the proper material. The articles mentioned the use of Viton A for both o-rings and bladders and stated that this compound is resistant to aromatic hydrocarbons.

Could you furnish the writer a source for acquiring o-rings and a list of manufacturers making bladders from Viton A? Also, do you have any figures showing the per cent swell of this compound in benzene?

B. A. PETERS
Humble Oil & Refining Co.
Houston, Tex.

We suggest contacting Elastomer Chemicals Div., E. I. du Pont de Nemours, Inc., Wilmington 98, Del.

ONE POINT OF VIEW

Award winners prove imaginative materials selection pays off

As yet there are few established formulas or rules to follow in selecting the right engineering materials for a part or product. This is both a strength and a weakness. It is a weakness, because without clear-cut procedures for a guide, the lazy or slip-shod engineer is less likely to do a thorough and competent selection job. On the other hand, this lack of formalism is a strength because it requires and encourages the alert engineer and designer to use his imagination and ingenuity.

Three good examples

The principal purpose of the M/DE Awards Competition for Best Use of Materials in Product Design is to stimulate this imaginative engineering approach to materials selection. We believe many of the winning designs in the 1957-58 Competition, presented in this issue (p 127), amply demonstrate this approach.

The First Award winner is an excellent example of how imaginative materials and design engineering can produce a new and entirely different materials-use concept. The new concept grew out of the search by Ryan Aeronautical Co. for a better and lighter aircraft structural and skin material. After trying and discarding a number of conventional materials and forms, they conceived of a way to use extremely thin steel sheet and still meet the strength and stiffness requirements. Their solution was surprisingly simple. It involves stiffening the steel foil by spot welding to it thin, miniature corrugations.

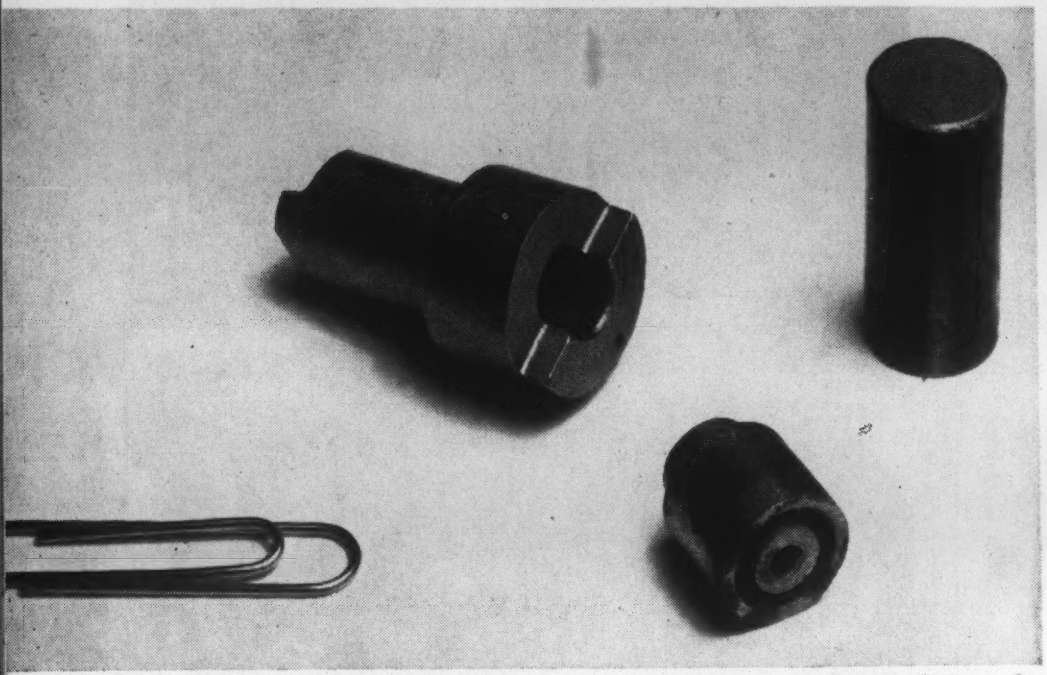
In another of the winning entries, what is usually considered a disadvantageous property in plastics—cold flow—became the basis of a new and successful design. The part was a miniature contact carrier. Teflon was chosen because its cold flow characteristics provided the carrier with just the right amount of interference against the housing to give the needed stability against shock and vibration.

Another winning entry clearly demonstrated that thorough and imaginative redesign is far better than just a routine modification if the full benefit from a new or different material is to be obtained. At first copper conductors were replaced by aluminum in an electrical busway without changing the design. The full potential of aluminum was not realized. Then a complete redesign was accomplished and only then were important weight and cost savings achieved.

Results worth the trouble

In reviewing these and other winners you will notice that in many cases cost reductions of over 50% were achieved, product performance was significantly improved, and substantially longer service life attained. From the simplest to the most complex, the winning entries show that an imaginative, as well as thorough-going engineering, approach produces worthwhile results.

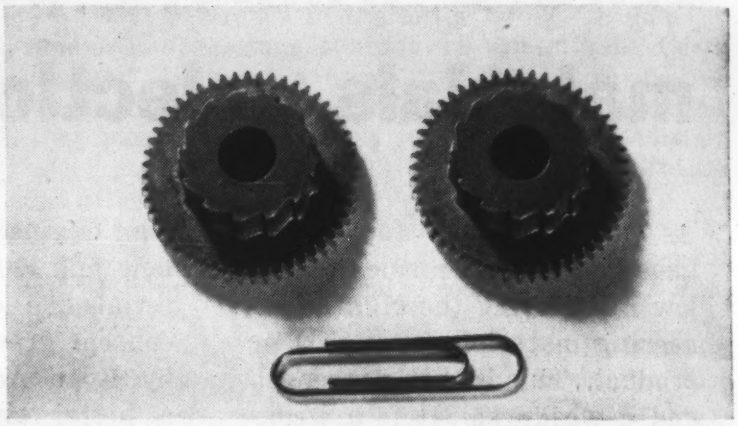
6 CASES WHERE METAL POWDER PARTS WERE CHOSEN


Revere Camera Co.

Slide projector parts *Bushing, stop and plunger are metal powder parts. The overtravel bushing (left) and the solenoid stop (front) formerly required extensive machining: the bushing has an offset flanged shape with shoulder on one end and lugs on other, as well as a shaft hole; the stop has projections on both ends, a deep parallel-side flange and a central hole. Both parts are now made of sintered steel at less cost—a savings of 20% in the case of the bushing. The porous structure of the bushing also permits impregnation with a molybdenum disulfide lubricant for lifetime service.*

The slide projector that uses these parts also has two self-lubricating, flanged, bronze bearings made by powder metallurgy to provide continuous oil film protection for important rotating parts.

Gear and ratchet *were formerly hobbed out and assembled. The mechanical properties required — especially shock and impact resistance — are comparatively high. The cost of the gear hobbed from wrought naval brass was approximately 20¢. Converted to a bronze powder part, the finished gear, including secondary coining operations, cost approximately 16¢. Mechanical properties were high, and resistance to shock and impact were greater than in the former hobbed gear.*


Yale & Towne Mfg. Co.

What to Consider in

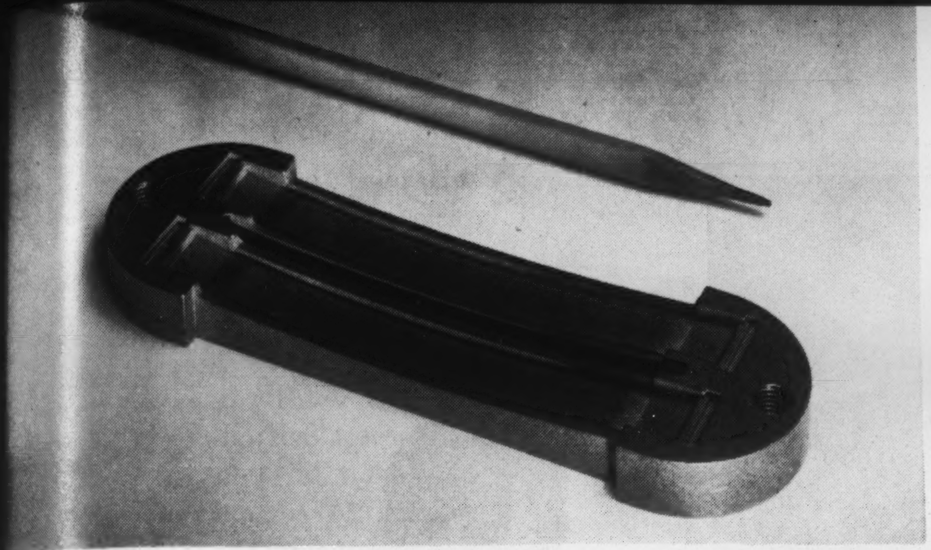
Choosing Powder Metallurgy

Determine the properties you need, study your design, figure your costs, and compare other processes. Metal compacts are often the answer.

by Kempton H. Roll, *Executive Secretary, Metal Powder Assn.*

1. Consider properties

Only within the past few years have parts produced by powder metallurgy processes been given as much consideration by designers and engineers as parts produced by better known processes such as casting and stamping. Formerly, powder metallurgy was considered a specialty operation to be selected only where other methods were not feasible. However, developments in presses and sintering furnaces, availability of improved powders, and perfection of techniques by producers have resulted in the production of parts having greatly improved



Brunner Div., Dunham-Bush, Inc.

←

Valve retainer *This sintered steel valve retainer almost 6 in. long is used in 100-hp refrigerator compressors. The valve retainer (which controls the action of the valve keeper) is a crucial component requiring close tolerances and good mechanical properties. Formerly, it was a precision casting. As an iron-copper-carbon part it has improved mechanical properties. Switching to powder metallurgy techniques also made it possible to obtain closer tolerances and produce fewer defective parts, thus eliminating scrap caused by rejects. Easier assembly and reduced inspection time effected further savings.*

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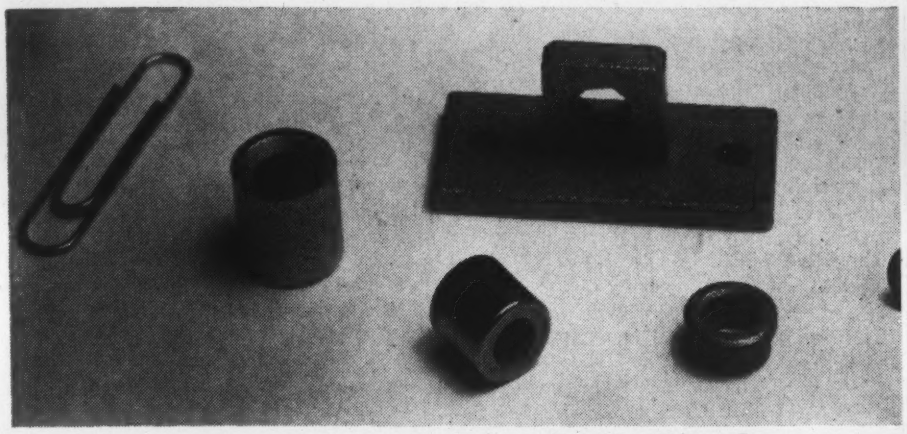

Superior Meter Co.

Gas meter parts *Bearings, bushings and brackets are oil-impregnated bronze powder metallurgy parts. Because of their friction-free surface and their corrosion resistance they play a key role in a meter designed to insure precise measurement of gas flow. For example, when the gas entering the meter exerts pressure on a gas-tight diaphragm, a flag and flag rod transmit the motion of the diaphragm to the recording index, thus registering the amount of gas used. Since accuracy of measurement depends on friction-free motion of these parts, oil-impregnated powdered bronze was specified for all bearings, bushings and brackets; these include the flag rod bearing, flag arm bushing and bearings, flag carriage bearings, and flag stuffing box bearings.*

Of equal importance is corrosion resistance. Both natural and manufactured gas contain some sulfur dioxide and may impair the operation of the meter by attacking vital components. Parts exposed to the gas, e.g., the flag arm rivet bushings, are of corrosion resistant bronze powder.

Another important feature of this meter is the double adjustable tangent which controls proper valve timing and diaphragm stroke, thus making calibration corrections a fast, simple operation. The tangent post bushing of oil-impregnated bronze insures friction-free operation. Under test conditions, this new meter has been in operation for the equivalent of two years without loss in accuracy or noticeable wear on the powder metallurgy parts. Although cost was not a primary factor in the choice of metal powder components, these parts are supplied at prices competitive with parts made by other fabrication techniques.

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properties. For example, only recently has it been possible to obtain high density iron powder parts for use under high stresses.

High density parts are made in two ways: 1) by additional pressing and sintering operations, and 2) by infiltration.

Maximum density, strength, ductility and dimensional stability are obtained by a second pressing or coining operation and a second sintering operation. Properties resulting are: tensile strength, 43,500 to 48,000 psi; yield strength, 27,500 to 29,000 psi; elongation, 11 to 25%.

Higher strength properties can be developed by carburizing and hardening. Depending on the amount of carbon added and the depth to which the parts are carburized, the following range of properties can be obtained: tensile strength, 90,000 to 200,000 psi; yield strength 78,000 to 200,000 psi; elongation, 0 to 4%.

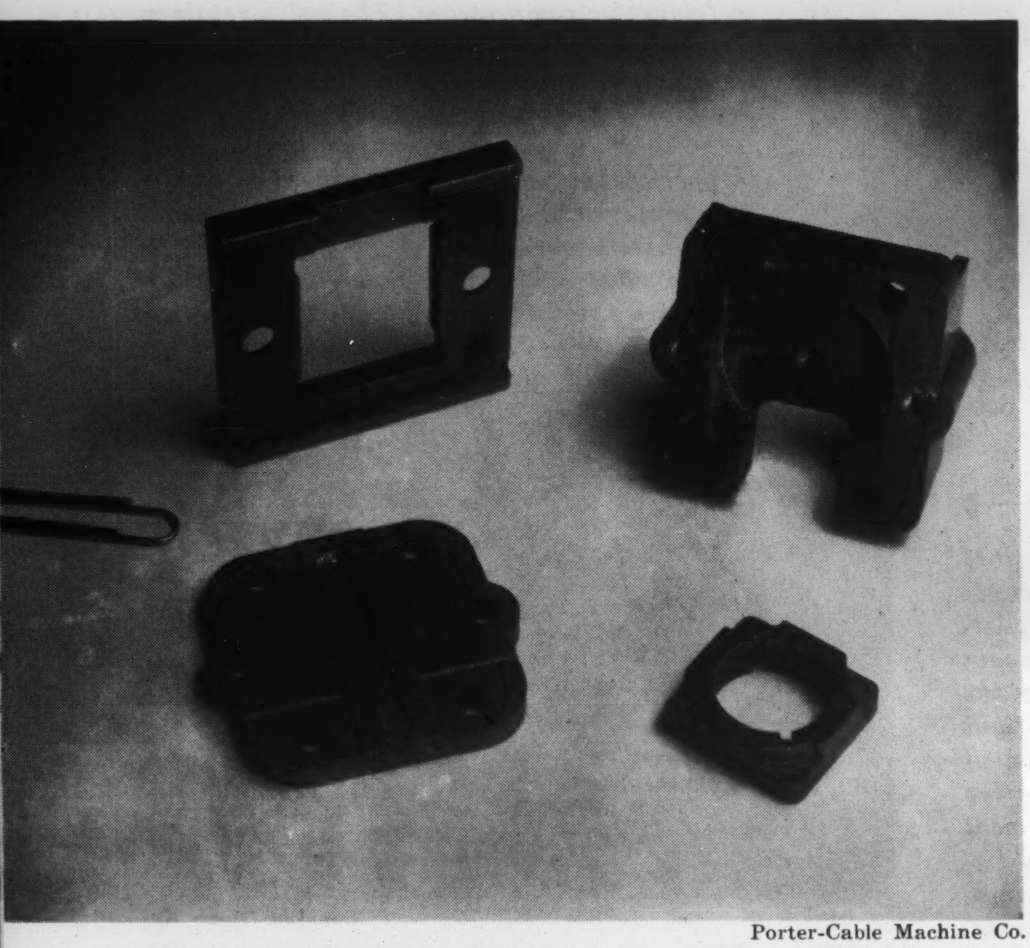
Copper or brass infiltration of iron skeletons is usually performed for two reasons: 1) to obtain higher strength and greater hardness values, and 2) to obtain more uniform density, particularly in parts with non-uniform or extremely heavy sections.

Three classes of infiltrated iron powder parts are produced, the class depending on the percentage of combined carbon. The accompanying table shows the strength and hardness properties usually obtained. These materials can be hardened by conventional quenching and tempering methods.

PROPERTIES OF INFILTRATED IRON POWDER PARTS

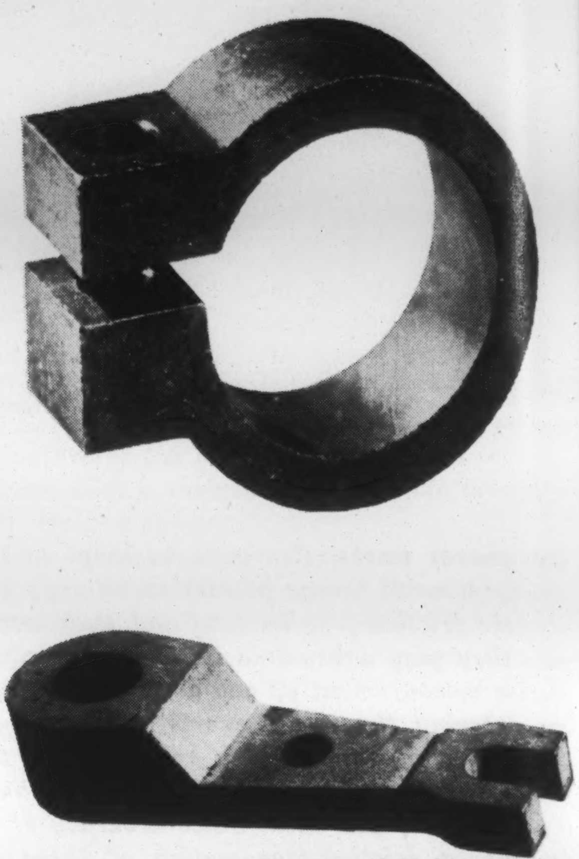
Class	Combined Carbon, %	Density, gm/cu cm	Ten Str, 1000 psi	Elong (1 in.), %	Compr Yld Str (0.1% offset), 1000 psi	Rockwell Hardness
A	0.25 max	7.1-7.6	65	1.0	70	B30-50
B	0.25-0.60	7.1-7.6	75	1.0	90	B50-70
C	0.60-1.0	7.1-7.6	100	0.5	120	B70-80

Source: Johnson, *Proc Metal Powder Assn.*, 12th Annual Meeting, 1956, p 73.



Porter-Cable Machine Co.

Electric saw parts *Retainer slide, holder saddle and drive block for blade are made by powder metallurgy. Drive block (lower right) moves in bearing retainer slide (upper left) to produce orbital blade movement which increases flexibility of motion and cutting speed in new electric bayonet saws. The retainer slide was designed for high density iron; the central rectangular hole is pressed to a size that produces a sliding fit with the drive block. The drive block is made of bronze powder; after grinding, it is case hardened to a depth of 0.008 to 0.013 in. The block is oil-impregnated for lifetime self-lubrication, an essential feature of this type of equipment.*



Addressograph-Multigraph Corp.

Duplicator parts *Mitre gear clamp and dictor roll arm are two of a number of powder metallurgy parts used in a multigraph duplicator. Made from brass powder, these parts maintain the necessary dimensional accuracy and, at the same time, effect substantial cost savings. Similar parts are widely used in other business machines.*

2. Consider cost

The user of materials often pays for mechanical properties not required in the performance of the product. By consciously designing for production by powder metallurgy, it is possible to obtain parts having sufficient strength for the application and, at the same time, gain cost advantages not offered by other processes. Tangible cost savings can also result from the flexibility of the process which enables the designer to obtain precisely the mechanical properties he needs. Remember, however, that special properties are usually obtained only at increased cost, as in all production processes.

To take full advantage of the inherent possibilities of powder metallurgy, the user should consult a qualified fabricator before he establishes his design details. He will thus have available the years of varied experience gained by the custom fabricator.

3. Consider design

Although specific design factors should be determined in each case, some general principles can serve as a guide for those contemplating the use of powder metallurgy parts. These principles should not be considered as stringent rules. Although they apply in general to parts made from iron, brass, bronze, copper, nickel silver and stainless alloy powders, each metal requires certain modifications in the process.

Powder metallurgy parts can be produced in a wide variety of shapes, sections and profiles. Secondary machining operations, where necessary, are usually relatively simple; typical operations are undercutting, drilling and tapping.

Parts with the following design features are especially well suited to the process:

1. Relatively thick sections which are cylindrical, rectangular or irregular, but do not involve large variations in cross-sectional dimensions. The ratio of length to diameter should not be more than 4 to 1 for parts less than 1 in. in dia, and considerably less as diameter increases.
2. Holes, counterbores, slots or keyways.
3. Simple flanges or projections at one end.
4. Splines, gear teeth or knurling.
5. Surface indentations.

Because of the relatively poor plastic flow of metal powders, certain limitations in design are inherent. Undercuts and side-cored holes cannot be produced readily. To achieve the strongest possible parts, it is usually best to avoid narrow or deep splines, feather edges, and sharp corners at the junction of a flange and the body.

For complicated shapes in which the length-to-diameter ratio varies with cross section, special dies to give complex motions are employed. In designing such parts, it is especially important to consult the fabricator in advance to make certain that the part is feasible. Newer multiple action presses are making the production of complicated-section parts more practicable.

Advantages of Metal Compacts

1. They allow replacement of more expensive metals and alloys.
2. They eliminate sub-assemblies by allowing redesign into one unit.
3. A wide range of ferrous and nonferrous metals and alloys can be used.
4. They are dimensionally stable even under high heat and humidity.
5. Their coefficient of friction is controllable, ranging from bearing to friction surfaces.
6. Their porosity can be controlled in localized regions to produce special oil-retaining characteristics for bearing surfaces, and to provide a cushioning effect in gears, cams, levers and other machine parts.
7. They are homogeneous—free from the voids and gas pockets common in cast parts. Because of their homogeneity, powder metallurgy parts produced under conditions yielding comparatively low strength can often replace cast parts theoretically having several times the strength.
8. They eliminate trimming costs, which in die cast parts and sand castings often exceed the cost of the castings itself.

4. Compare with other methods

A quick look at some other metal forming processes will indicate more clearly the peculiar advantages of powder metallurgy.

Die casting offers comparative freedom of design, since a molten alloy is used. Good tolerances and good surface finish can be obtained, and low cost per piece is the general rule. The greatest disadvantage of this process is that it cannot be adapted to the production of ferrous metal parts, with their high strength properties.

Investment casting gives excellent surface finishes and close tolerances. However, cost per piece is high because of inherent low production rates.

Extrusion gives high mechanical properties, but tolerances are wide, and cost per piece is high because of the large number of secondary operations required.

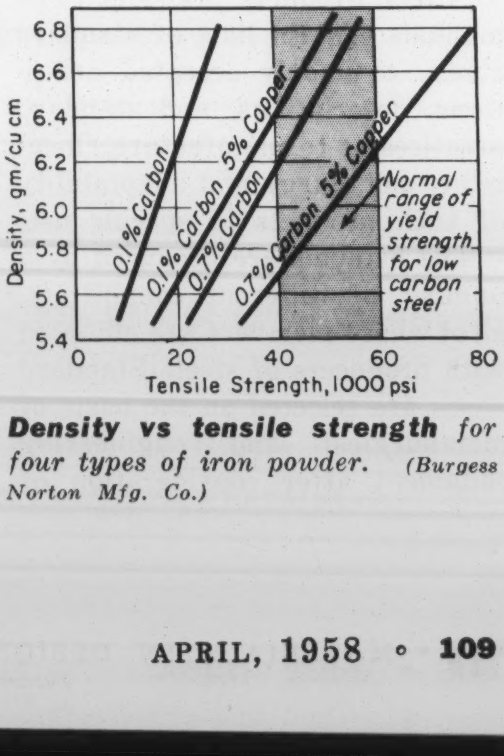
Screw machining offers comparatively low tooling costs; since the production rate is usually high, unit costs can be quite low. However, the types of parts that can be made are limited.

Machining in general offers great freedom of design, and excellent surface finishes and close tolerances can be obtained. In most cases, however, cost per finished piece is high because of costly setups and comparatively slow production rates.

Stamping or blanking offers limited design possibilities. Although cost per finished piece is generally low because of the high production rate, only a limited variety of shapes can be made.

Forging processes offer high physical properties, but lack design flexibility.

Powder metallurgy, on the other hand, is a close tolerance, high production process that differs from the other processes in one important manner: Powder metallurgy techniques permit a part to be made deliberately porous to varying degrees and in selected areas. Thus, density can be considered a new controllable variable just as degree of cold work is a controllable variable in wrought products. The ability to control density in turn allows flexibility in controlling physical properties (see below).



Density vs tensile strength *for four types of iron powder.* *(Burgess Norton Mfg. Co.)*

Guide to Materials Standards and Specifications

Part 2—Iron and Steels

by **S. P. Kaidanovsky,** *Consulting Engineer*

■ Standards and specifications on ferrous metals and alloys are prepared or issued by most of the governmental agencies and national standards organizations described in the first article of this series. These include the Federal Supply Service, Dept. of Defense, American Society for Testing Materials, Society of Automotive Engineers and American Standards Assn. In addition, several trade associations concerned with iron and steels prepare standards or assist standards agencies. They are: American Iron and Steel Institute, Alloy Casting Institute, Investment Castings Institute, Gray Iron Founders' Society, Steel Founders' Society of America and Metal Powder Assn.

This article discusses the standards activities of all of these organizations; the iron and steel standards and specifications issued by them are summarized in Table 1.

American Iron and Steel Institute

The AISI is a nonprofit organization of the iron and steel industry. It prepares an extensive series of Steel Products Manuals. The manuals contain lists of standard steels, commonly accepted definitions, descriptions, and standard practices as to manufacture, chemistry, metallurgy and adaptability of such products to specific use.

The manuals are produced by a number of different committees, all of whose members are affiliated with producers of steel. Standard steels are selected on the basis of metallurgical and engineering judgment after consideration of many factors, including the advice and counsel of engineering and specification writing bodies, and the needs of armed services. The list of standard steels is altered from time to time to accommodate steels of proved merit and to provide for changes in the metallurgical and engineering requirements of industry. The AISI assists the Dept. of Defense and other specifications-writing bodies in preparing and revising specifications for iron and steel products.

The system used to identify standard steels is given in Table 2. Following is an explanation of the system used for the various groups of standard steels.

Carbon steels—The designation system for carbon steels consists of a capital letter prefix and four numerals. The prefix indicates the principal steelmaking process by which the steel was made. Letter *B* denotes acid bessemer; *C* denotes basic open hearth or basic electric furnace. The first numeral after the letter prefix is always *1*, representing the carbon steel grades. The second numeral designates the type of carbon steel (see Table 2). The last two numerals indicate the approximate middle of the carbon range for the steel. For example, in the grade designation *1035*, 35 represents a carbon range of 0.32 to 0.38%.

About This Series

This is the second in a series of six articles on materials standards and specifications. The first (published last month) described the materials standards and specifications produced by Government agencies and organizations concerned with a wide range of materials. This article deals with irons and steels; subsequent articles will deal with organizations and standards on nonferrous metals, plastics and elastomers, other nonmetallics, and finishes.

Low alloy steels—A four numeral system is also used for the standard low alloy steels. The first numeral indicates the alloy type (i.e., *2* is nickel, *3* is nickel-chromium, etc.). In the case of simple alloy steels, the second numeral gives the approximate percentage of the principal alloying element. In some instances, it has been necessary to depart from this system of identifying the approximate alloy content to accommodate grades such as the triple alloy steels. As with carbon steels, the last two digits of the four-numeral series indicate the approximate middle of the carbon range. The prefix letter *E* is used to designate steels made by the electric furnace process. The prefix letter *X* indicates a grade modification.

Stainless and heat resisting steels—A system of numbers is used to identify stainless and heat resisting steels by type and according to four general groups. In a three-numeral series, the first numeral indicates the group and the last two numerals indicate the type. Modification of types are indicated by suffix letters.

Society of Automotive Engineers

Wrought steels—SAE Iron and Steel Standards and Recommended Practices are prepared by the SAE Iron and Steel Technical Committee. The membership consists of steel producers and steel users. Aeronautical Materials Specifications (AMS) for carbon and low alloy steels are prepared by the AMS Carbon and Low Alloy Steel and Titanium Committee, and for corrosion and heat resist-

TABLE 1—SUMMARY LIST OF STANDARDS AND SPECIFICATIONS FOR IRON AND STEELS

Organization	Type of Document	Document Identification	Material	Forms and/or Uses
CARBON STEELS—WROUGHT				
AISI	Std	—	Carbon Steels	Semifinished blooms, billets and slabs for forging; hot rolled and cold finished bars; wire rods
SAE	Std	—	Carbon Steels	Semifinished for forging, hot rolled and cold finished bars; wire rods, seamless tubing, structural shapes; plate, strip, sheet, welded tubing
SAE	Mtl Spec	AMS XXX	Carbon Steels	Bars, forgings, wire, cold rolled sheet and strip, seamless and welded tubing
ASTM	Spec	AXXX-Year	Carbon Steels	Cold finished, heat treated, hot rolled bars; blooms, billets and slabs for forging; commercial quality, cold rolled sheet
Federal	Spec	QQ-S-XXX	Carbon Steels	Bars (general purpose), plate, sheet, strip, seamless and welded mechanical tubing
Military	Spec	MIL-S-XXX	Carbon Steels	Hot rolled or forged blooms, billets and slabs for reforging; bars (aircraft quality, cold finished, free machining); hot rolled bars; sheet and strip (uncoated, aircraft quality)
ASA	Spec	G50.1-Year	Carbon Steels	Miscellaneous Industrial Uses
LOW ALLOY STEELS—WROUGHT				
AISI	Std	—	Nitriding and Boron Steels	Bars, billets, blooms, slabs
AISI	Tent. Std.	—	Alloy and Boron Steels	Bars, billets, blooms, slabs
AISI	Std	—	Hardenability (H) Steels	Bars, billets, blooms
AISI	Tent. Std.	—	Hardenability (H) Steels	Bars, billets, blooms
AISI	Std	—	Boron (H) Steels	Bars, billets, blooms
AISI	Tent. Std.	—	Boron (H) Steels	Bars, billets, blooms
SAE	Std	—	Low Alloy Steels	Billets, blooms, slabs, hot and cold rolled bars
SAE	Mtl Spec	AMS XXX	Low Alloy Steels	Bars, forgings, mechanical tubing, plate, sheet, strip, spring wire and sheet
ASTM	Spec	AXXX-Year	Low Alloy Steels	Bars, forgings, plate, sheet, strip, tubing, wire
Federal	Spec	QQ-S-XXX	Low Alloy Steels	Bars, plate, sheet, strip, tubing
Military	Spec	MIL-S-XXX	Low Alloy Steels	Bars, forgings and finished pieces; forgings (for special high temperature application); bars, rods and forging stock (aircraft quality); plate, sheet and strip (aircraft quality)
HEAT AND CORROSION RESISTANT STEELS—WROUGHT				
AISI	Std	—	Heat and Corrosion Resistant Steels	Plate, sheet, strip, bars, round and flat wire; tubing, rods, blooms, billets, slabs, rounds
SAE	Std	—	Heat and Corrosion Resistant Steels	General application
SAE	Mtl Spec	AMS XXX	Heat and Corrosion Resistant Steels	Plate, sheet, strip; hydraulic, seamless, welded tubing; bars, forgings
ASTM	Spec	AXXX-Year	Heat and Corrosion Resistant Steels	Billets, bars, plate, sheet, strip
Federal	Spec	QQ-S-XXX	Heat and Corrosion Resistant Steels	Plate, sheet, strip, bars, forgings
Military	Spec	MIL-S-XXX	Heat and Corrosion Resistant Steels	Bars, billets, plate, sheet, strip, forgings
CAST IRONS				
SAE	Spec	—	Gray Iron	Automotive and allied industries
ASTM	Spec	AXXX-Year	Gray Iron	Automotive; valves, flanges, pipe fittings; lightweight and thin-sectioned castings; pressure and non-pressure uses
Federal	Spec	QQ-I-XXX	Gray Iron	General application
GIFS	Specs Summary	—	Gray Iron	Typical applications given in Summary
ASA	Spec	G25.1-Year	Gray Iron	General application
ASA	Spec	G27.1-Year	Gray Iron	Lightweight and thin sections
SAE	Spec	—	Malleable Iron	General, automotive, agricultural implement, general machine purposes

continued

TABLE 1 (continued)—SUMMARY LIST OF STANDARDS AND SPECIFICATIONS FOR IRON AND STEELS

Organization	Type of Document	Document Identification	Material	Forms and/or Uses
CAST IRONS—Continued				
Federal	Spec	QQ-I-XXX	Malleable Iron	General application
ASTM	Spec	AXXX-Year	Malleable Iron	General application
Military	Spec	MIL-I-XXX	Malleable Iron	General application
ASA	Spec	G48.1-Year	Malleable Iron	General application
SAE	Spec	—	Pearlitic Malleable Iron	Motor vehicle, marine, agricultural implement and general machining purposes, both for general use and for localized hardening purposes
SAE	Mtl Spec	AMS XXX	Pearlitic Malleable Iron	Aeronautical application
ASTM	Spec	AXXX-Year	Cupola Malleable	General application
ASA	Spec	G49.1-Year	Cupola Malleable	General application
SAE	Spec	—	Nodular (ductile) Irons	Motor vehicles, agricultural equipment, general machine purposes
SAE	Mtl Spec	AMS XXX	Nodular (ductile) Irons	Aeronautical use
ASTM	Spec	AXXX-Year	Nodular (ductile) Irons	High strength, elevated temperatures
Military	Spec	MIL-I-XXX	Nodular (ductile) Irons	General application
GIFS	Specs Summary	—	Nodular (ductile) Irons	Typical applications given in Summary
CAST STEELS				
SAE	Rec Prac	—	Carbon and Low Alloy Steels	Automotive and allied industries
SAE	Rec Prac	—	Carbon and Low Alloy Steels	Investment castings for automotive requirements
SAE	Mtl Spec	AMS XXX	Carbon and Low Alloy Steels	Investment and sand castings (aeronautical)
ASTM	Spec	AXXX-Year	Carbon and Low Alloy Steels	High and low temperature service; general application; mild to medium strength
Federal	Spec	QQ-S-XXX	Carbon and Low Alloy Steels	General application
Military	Spec	MIL-S-XXX	Carbon and Low Alloy Steels	General application
SFSA	Rec Min Std	—	Carbon Steels	General application
SFSA	Specs Summary	—	Carbon, Low and High Alloy Steels	General application
ICI	Spec	FE-1	Carbon Steels	Investment castings
ICI	Spec	FE-2	Low Alloy Steels	Investment castings
SAE	Mtl Spec	AMS XXX	Corrosion and Heat Resistant Steels	Investment, sand and centrifugal castings (aeronautical)
SAE	Mtl Spec	AMS XXX	Iron, Cobalt and Nickel-Base Alloys	Investment castings (aeronautical)
SAE	Std	—	Corrosion Resistant Steels	Automotive and allied industries
SAE	Std	—	Heat Resistant Steels	Automotive and allied industries
ASTM	Spec	AXXX-Year	Corrosion and Heat Resistant Steels	General application
Federal	Spec	QQ-S-XXX	Heat and Corrosion Resistant Steels	General application
Military	Spec	MIL-S-XXX	Heat and Corrosion Resistant Steels	General application
ACI	Std	—	Heat and Corrosion Resistant Steels	Application given in ACI Data Sheets
IRON AND STEEL POWDERS				
ASTM	Spec	AXXX-Year	Iron Powder	Parts, bearings
Military	Spec	MIL-M-XXX	Iron Powder	Iron powder parts
MPA	Specs Summary	DS4	Metal Powders	Parts, bearings
MPA	Std	mpa XX-Year	Iron Powder	Parts, bearings, cores

ing steels and alloys by the AMS Corrosion and Heat Resisting Alloys Committee.

The SAE Iron and Steel Technical Committee cooperates with the AISI on standardization of chemical compositions and related data on steels used in the automotive industries. No change in composition or additions or deletions of steel numbers are made by either the SAE or AISI without first informing the other of the proposed changes and holding open discussion between both groups to insure that any changes are made simultaneously.

As the result of cooperative work of SAE and AISI, hardenability bands to which alloy steels can be specified have been devised. The hardenability limits and their conditions of use have been standardized. The SAE and AISI committees continue to collect and compile all information on steels furnished to hardenability limits to determine what modifications are needed. Steels specified to hardenability band limits are identified by the suffix letter *H* added to the conventional steel designation.

The designation system for the SAE standard steels is basically the same as the AISI system described earlier in this article. However, there are a few minor differences. The letter prefix indicating the steelmaking process is not used by SAE. Also, the numbers for heat and corrosion resistant steels differ in certain respects, as shown in the footnotes to Table 2.

Automotive nodular cast irons—The SAE grade designation is composed of three parts, each part consisting of two numbers. The first two numbers express the tensile strength in thousands of pounds, the next two numbers express the yield strength in thousands of pounds, and the last two numbers express percent elongation. Thus, the SAE grade designation for ferritic nodular cast iron of 60,000 psi tensile strength, 40,000 psi yield strength and 10% elongation is *60-40-10*.

Automotive steel castings—All plain carbon and low alloy cast steels specified by chemistry carry a prefix *00*, followed by the first two figures of the maximum carbon content. Thus, the SAE grade for low carbon steel suitable for carburizing with a maximum carbon content of 0.22% is *0022*.

All high strength steels specified by tensile properties carry a prefix *0*, followed by numbers expressing the minimum tensile strength in thousands of pounds. Thus, the SAE grade for high strength steel castings of 105,000 psi tensile strength is *0105*. All high strength steels specified by tensile properties *and hardenability* carry prefix *0* and in addition a suffix *H* with a letter attached that corresponds to the hardenability band desired, e.g., HA, HB, HC.

Carbon and low alloy steel investment castings—All plain carbon steels specified by chemistry carry a prefix *00* followed by the first two figures of maximum carbon content. Thus, SAE grade for plain carbon steel investment castings with maximum carbon of 0.50% is *0050*.

All low alloy steels specified by physical properties carry a prefix *0* followed by numbers expressing the minimum tensile strength in thousands of pounds. Thus, the SAE grade for low alloy steel investment castings of 150,000 psi tensile strength is *0150*.

Alloy Castings Institute

The ACI is supported by a group of foundries producing high alloy, heat resistant and corrosion resistant castings. Because the ACI is composed of producers only, it does not attempt to write specifications of its own, but cooperates with specification writing bodies. However, ACI has developed a system of standard nomenclature for various alloy compositions. The ACI standard nomenclature is now employed in the ASTM specifications on these materials. Other groups, such as SAE and the Navy, for example, have adopted the chemical ranges covered by the ACI designations.

TABLE 2—DESIGNATION SYSTEM FOR WROUGHT STANDARD STEELS[a]

Series	Type of Steel and Avg Alloy Content, %
CARBON STEELS	
10XX	Nonsulfurized carbon steel (plain carbon)
11XX	Resulfurized carbon steel (free machining)
12XX	Resulfurized and rephosphorized carbon steel
LOW ALLOY STEELS	
13XX	Manganese 1.75
23XX	Nickel 3.50
25XX	Nickel 5.00
31XX	Nickel 1.25, chromium 0.65
33XX	Nickel 3.50, chromium 1.55
40XX	Molybdenum 0.25
41XX	Chromium 0.50 or 0.95, molybdenum 0.12 or 0.20
43XX	Nickel 1.80, chromium 0.50 or 0.80, molybdenum 0.25
46XX	Nickel 1.55 or 1.80, molybdenum 0.20 or 0.25
47XX	Nickel 1.05, chromium 0.45, molybdenum 0.20
48XX	Nickel 3.50, molybdenum 0.25
50XX	Chromium 0.28 or 0.40
51XX	Chromium 0.80, 0.90, 0.95, 1.00 or 1.05
5XXXX	Chromium 0.50, 1.00 or 1.45, carbon 1.00
61XX	Chromium 0.80 or 0.95, vanadium 0.10 or 0.15 min
86XX	Nickel 0.55, chromium 0.50 or 0.65, molybdenum 0.20
87XX	Nickel 0.55, chromium 0.50, molybdenum 0.25
92XX	Manganese 0.85, silicon 2.00
93XX	Nickel 3.25, chromium 1.20, molybdenum 0.12
98XX	Nickel 1.00, chromium 0.80, molybdenum 0.25
HEAT AND CORROSION RESISTANT STEELS	
2XX	Chromium-nickel-manganese (nonhardenable, austenitic, nonmagnetic)
3XX[b]	Chromium-nickel (nonhardenable, austenitic, nonmagnetic)
4XX[c]	Chromium (hardenable, martensitic, magnetic)
4XX[c]	Chromium (hardenable, ferritic, magnetic)
5XX[c]	Chromium (low chromium, heat resisting)

[a] Suffix *H* denotes H steels, as in 1330H. Prefix *TS* denotes tentative standard steel, as in TS4140. *B* denotes boron steels, as in 46B12. TSXXBVXX denotes tentative standard boron vanadium steel, as in TS43BV12.

[b] SAE designations use prefix of 30 (e.g., 303XX).

[c] SAE designations use prefix of 51 (e.g., 514XX).

In the ACI nomenclature, designations with the initial letter *C* indicate alloys generally used to resist corrosive attack at temperatures less than 1200 F. Designations with the initial letter *H*

Where to Obtain Standards for Irons and Steels

American Iron and Steel Institute
150 E. 42nd St., New York 17, N. Y.

Steel Products Manuals on various steel mill products and current list of available manuals.

American Society for Testing Materials
1916 Race St., Philadelphia 3, Pa.

ASTM Standards, Part 1—Ferrous Metals. Each standard available separately.[a]

Society of Automotive Engineers
485 Lexington Ave., New York 17, N. Y.

SAE Handbook. TR-30, reprint from SAE Handbook. Each AMS available separately.[a]

U. S. Government.
Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C.

Federal and Military Specifications. Each standard available separately.[a]

American Standards Assn.
70 E. 45th St., New York 17, N. Y.

Each standard available separately.[a]

Alloy Casting Institute
286 Old Country Rd., Mineola, N. Y.

ACI Standard Designations and Chemical Composition Ranges for Heat and Corrosion Resistant Castings and ACI Data Sheets.

Investment Casting Institute
27 E. Monroe St., Chicago 3, Ill.

Investment Castings Specifications.

Gray Iron Founders' Society
National City-E. 6th Bldg., Cleveland 14, Ohio

Summary of Specifications for Gray Cast Irons.

Steel Founders' Society of America
606 Terminal Tower, Cleveland 13, Ohio

Summary of Steel Castings Specifications and General Engineering Types of Steel Castings.

Metal Powder Assn.
130 W. 42nd St., New York 36, N. Y.

Summary of "Standards, Specifications for Metal Powders and Metal Powder Products."

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[a] See first article (Mar '58) for information on index.

Note: Use of standards issued by trade associations should not be considered mandatory.

indicate alloys generally used under conditions where the metal temperature exceeds 1200 F. The second letter represents the nominal chromium-nickel type, the nickel content increasing in amount from *A* to *X*. For example, *F* stands for the 19 chromium-9% nickel, *K* for 25 chromium-20% nickel, and *W* for the 12 chromium-60% nickel alloy types.

Numerals following the letters indicate carbon content: in the corrosion resistant grades the *maximum* carbon content; in the heat resistant grades, the *midpoint* of a ±0.10% carbon range. If special elements are included in the composition, they are indicated by the addition of a letter to the symbol. Thus, *CF-8M* is an alloy for corrosion resistant service, is of the 19 chromium-9% nickel type, has a maximum carbon content of 0.08%, and contains molybdenum.

Investment Casting Institute

The ICI is the national trade association representing manufacturers of investment castings. The ICI has developed its own specifications for producers and users of investment castings. The specifications are designated by two letters followed by a serial number. Thus, carbon and alloy carbon steels are designated by *FE*, corrosion and heat resistant nickel-base alloys by *NI*, cobalt-base alloys by *CO*, aluminum-base alloys by *AL*, magnesium-base alloys by *MG*, etc.

Gray Iron Founders' Society

The GIFS is a national trade association of the gray iron casting industry. The society does not prepare its own specifications. Its technical activities are carried out largely in cooperation with the ASTM, ASA and the American Society of Mechanical Engineers. It does publish a Summary of Specifications for Gray Cast Irons and Nodular (Ductile) Cast Irons, intended to cover the more commonly used specifications.

Steel Founders' Society of America

The SFSA prepares very few standards and specifications on its own. Through representation on technical committees of other organizations, it cooperates in developing standards and specifications for products of the steel foundry industry. It cooperates mainly with technical committees of the ASTM in the development of standards, specifications and methods of test for steel and steel castings.

The Society has issued a Recommended Minimum Standard for Commercial Carbon Steel Castings. It publishes a Summary of Specifications for Carbon and Low Alloy Cast Steels and for High Alloy Cast Steels, covering the more commonly used specifications.

Metal Powder Assn.

The MPA is a trade association composed of metal powder producers, metal powder parts fabricators and equipment suppliers. MPA standards are initiated and prepared by committees in the divisions of the Association, such as the Powder Producers Div., Fabricators Div., etc.

The MPA works closely with the ASTM. Because of the nature of its organization, MPA can prepare and publish a standard in far less time than the ASTM. After usage, an MPA standard may be revised, amplified and subsequently adopted by the ASTM as a standard. Each standard is identified by the insignia *mpa*, followed by a number indicating the order in which the standard has been adopted and the year of adoption. For example, Electronic Iron Core Preferred Dimensional Specifications, the eleventh standard issued by the MPA, is *mpa 11-57*.

Ceramic coatings . . metallic coatings . . special paints . . for

Protecting Metals at High Temperatures

by **Alfred F. Hofstatter,** *Metallurgist, Ryan Aeronautical Co.*

Ryan Aeronautical Co.

***Engine manifold** and other aircraft parts are protected by ceramic coatings.*

Ceramic coatings

are particularly important because of their hardness and resistance to oxidation.

The term ceramic coatings will be used to encompass three basic materials: pure oxide refractories; mixed refractories; and cermets or mixtures of ceramic refractories and metals.

Pure oxide refractories

The melting points and expansion coefficients of some principal oxide refractories are listed in Table 1 on p 116. Unlike metals, which begin to oxidize and decompose far below their melting points, these oxides deform at or near their melting points without any prior decomposition. Melting points of the oxides are lowered by mixing them or by adding impurities. As the table shows, the coefficients of expansion of the pure oxide refractories are about half that of steel. For this reason it is difficult to produce a ceramic-to-metal bond that will withstand thermal cycling.

Pure oxides cannot be fused to metal parts by normal dip and bake methods, since slurry temperatures are above the melting temperatures of metals. However, the coatings can be applied by spraying. A rod of fused or powdered oxide is simultaneously melted and sprayed by being fed through a high velocity oxyacetylene flame at 5000 F. The molten particles cool rapidly during projection but retain enough plasticity to deform on impact, producing an even, dense coating.

To date, the most common oxide used is aluminum oxide. This material has good thermal shock properties, low porosity and high hardness. It is anticipated that alumina can increase the high temperature limit of a metal as much as 1000° F beyond its unprotected use temperature. For short, one-shot applications, aluminum oxide coatings can probably be used as high as 3000 F, but under repeated or constant use the bond (not the material) fails. The maximum temperature values listed in Table 2 (p 117) are for constant or repeated use. Other oxides, especially those of zirconium and silicon, are being adapted to spraying for further investigation.

Mixed refractories

One of the earliest ceramic coatings developed for high temperature protection consisted of a mixture of two enameling frits plus aluminum oxide. Known as A-19, this ceramic coating protected mild steels up to 1250 F, and was extensively used until temperature requirements rose above the strength limitations of mild steels. Subsequent research produced the A-417 and A-418 ceramic coatings for stainless steels.

The A-418 coating is widely used today for protecting stainless steel parts. Basically, it is a mixture of the oxides of barium, silicon, calcium, zinc, iron and chromium. It is applied to clean surfaces as a slurry or slip, dried at room temperature, and then baked at 1860 F for 10 min. The coating forms a hard, nonporous shell, 1 to 2 mils thick that withstands temperatures up to 1700 F for long periods. Tests on aircraft exhaust manifolds have shown that the performance of coated

19-9SL stainless steel is equal to or better than that of nickel or cobalt superalloys.

Cermets

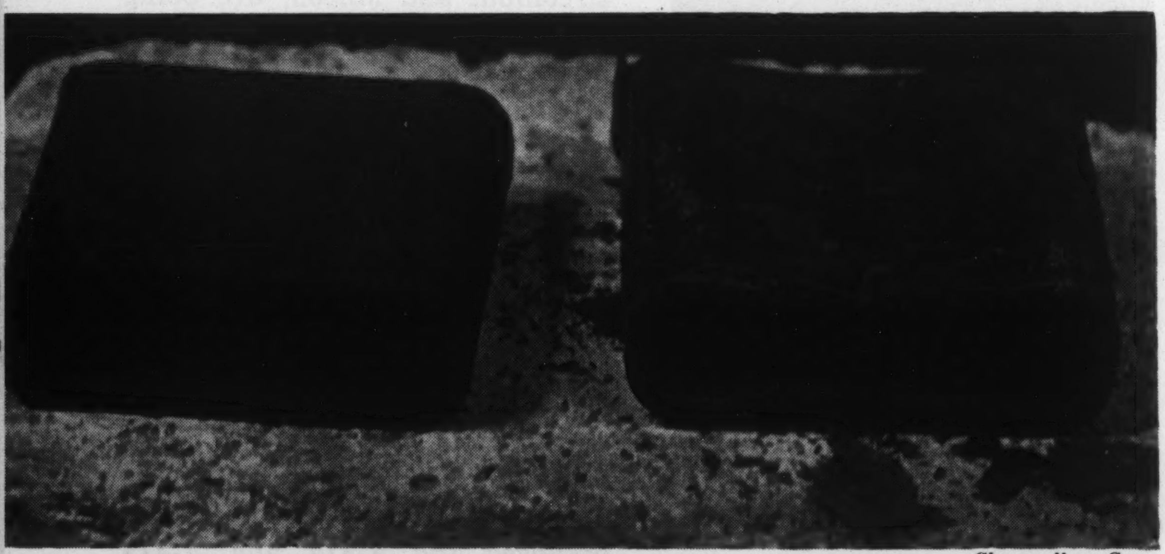
A compromise of properties can be obtained by utilizing the high heat resistance of ceramics and the strength and good thermal shock resistance of metals. A popular ceramic-metal combination coating consists of 92% tungsten carbide and 8% cobalt. The coating is sprayed on and, despite high temperatures at the gun, temperatures at the work surface do not exceed 400 F. Coatings 2 mils thick have withstood 500 cycles of rapid heating to 1350 F without failure. Porosity is less than 0.5%, an indication of good oxidation protection. The coating has been used in jet engine seal rings as a dry bearing surface operating at 800 F.

A nitrided case is essentially a cermet although it may not be thought of as such. It consists of metallic nitrides (mainly aluminum) with the base metal as a binder. Nitriding, which is limited to certain grades of steel, forms an extremely hard case (1000 DPN) which is not subject to fatigue and retains hardness up to 1100 F. In general, nitriding neither reduces nor increases the corrosion resistance of the base metal.

TABLE 1—THERMAL PROPERTIES OF PURE OXIDE REFRACTORIES

Type ⬇	Melting Point, F	Coef of Ther Exp, 10^{-6} per °F
Stainless Steel (321)	2555	11.2
Zirconia (ZrO_2)	5342	3-6
Thorium Oxide (ThO_2)	5072	5
Calcium Oxide (CaO)	4662	8
Beryllium Oxide (BeO)	4658	5
Magnesium Oxide (MgO)	4532	8
Titanium Dioxide (TiO_2)	3870	4
Aluminum Oxide (Al_2O_3)[a]	3722	5
Chromium Oxide (Cr_2O_3)	3614	7
Cerium Oxide (CeO_2)	3542	—
Barium Oxide (BaO)	3497	—
Silicon Dioxide (SiO_2)[b]	3100	7

[a] Commonly known as alumina.
[b] Commonly known as silica.



Chromalloy Corp.

Strip heater *segment when chromized (left) remains intact after 8-hr exposure at 1750 F.*

Metallic coatings

are characterized by their combination of wear and corrosion resistance.

One of the oldest methods of protecting a structural metal against heat or oxidation is to cover it with a skin of a less active metal. A considerable number of protective metal coatings for high temperatures are available, including: aluminum, chromium, nickel, silicon, copper, silver, tungsten, molybdenum, and stainless steel alloys. These coatings may be electroplated, diffused, dipped, sprayed or clad onto the base material. (Zinc, cadmium and tin coatings are not included, as their use over 500 F is very limited.)

Aluminum

Two basic types of aluminum can be used as protective coatings: the diffused (or calorized) type which is primarily used on steels, and aluminum cladding which is used on both aluminum alloys and steels.

In general, parts that have been calorized or clad with aluminum will withstand oxidizing atmospheres (especially combustion gases) up to 1400 F for long periods of time. The coatings are also distinguished for their heat reflective properties. Temperatures above 1600 F can be tolerated but life is reduced accordingly.

Essentially, a calorized coating on steel consists of an iron-aluminum layer. The coating can be produced by several methods. The original method employed aluminum powder in which parts were tumbled under inert gas and heated to austenitic temperatures. This method produced a shallow aluminum-iron coating—up to 6 mils thick—which had excellent heat and corrosion resistance but was brittle and spalled easily. It was then found that subsequent heating would diffuse the alloy layer further (up to 40 mils deep) until the amount of aluminum in the layer was reduced to 25%. Such a coating exhibits good heat and corrosion resistance and is tougher and less brittle than the thinner, unheated coatings.

In addition to the above pack method, parts can also be calorized by dipping in molten aluminum. This method (similar to galvanizing) produces a coating consisting principally of aluminum with only a thin layer of bonding alloy. Aluminum-iron coatings can also be obtained by treating steel parts in aluminum chloride vapor at high temperatures. A comparatively pure layer of aluminum can be obtained by metal spraying and by painting. Aluminum can also be plated from a non-aqueous solution of aluminum chloride.

A comparatively pure aluminum surface such as a cladding may be desirable in some applications. Cladding of sheet steel by hot dipping and then rolling is becoming popular. Other methods such as Aldip (General Motors), Al-Fin (Fairchild) and Mollerizing are also used. All of these produce a diffusion layer over the base metal and an outer layer of pure aluminum.

At temperatures near or above their melting points, aluminum claddings or coatings will form a calorized coating. Calorized coatings have good resistance to dry corrosive conditions at high temperatures, but fail rapidly under wet conditions. A clad surface performs better at lower temperatures where water vapor or condensation may be encountered. A further advantage of clad coatings is that they can be easily fabricated, whereas calorized coatings tend to be more brittle.

Chromium

The two most widely used chromium coatings are applied by electroplating or chromizing. Electroplated coatings can be applied to almost any base metal, whereas chromized coatings are usually applied to steel.

A hard chromium electroplate can be used as a corrosion and erosion inhibitor for temperatures up to 2000 F. The coating also has an extreme hardness of 1000 Brinell at room temperature, but hardness falls off to 200 Brinell at 2200 F. Other significant advantages of the coating are its antigalling properties, low coefficient of friction and non-wetting properties.

Hard chromium electroplates are principally used to improve wear resistance at elevated temperatures. They are particularly suitable for short-time rocket motor applications where high temperatures, corrosion and erosion are encountered.

Chromium diffusion, or chromizing, is very similar to vapor deposition of aluminum; a gaseous chromium compound reacts with steel, substituting chromium for iron on the surface. Properties of the coating depend on the carbon content of the steel. On low carbon (up to 0.20%) steels chromizing forms a layer similar to annealed ferritic stainless steel; on steels with higher carbon contents chromizing forms a hard surface layer of chromium carbides. The low carbon chromized coatings are good for service up to about 1600 F under oxidation and erosion conditions. The chromium carbide coatings are not particularly suitable for high temperature applications.

A promising new chromizing process is being developed. In this process a chromizing mixture, along with glass frits, is applied to the steel surface and heated in air to 1900 F, allowing the glass to fuse and form a protective outer layer while the chromium diffuses into the base metal. During cooling the glass flakes off, leaving a clean chromized surface. Low carbon steels processed by this method have resisted scaling up to 2100 F and can be bent, formed and welded.

Nickel

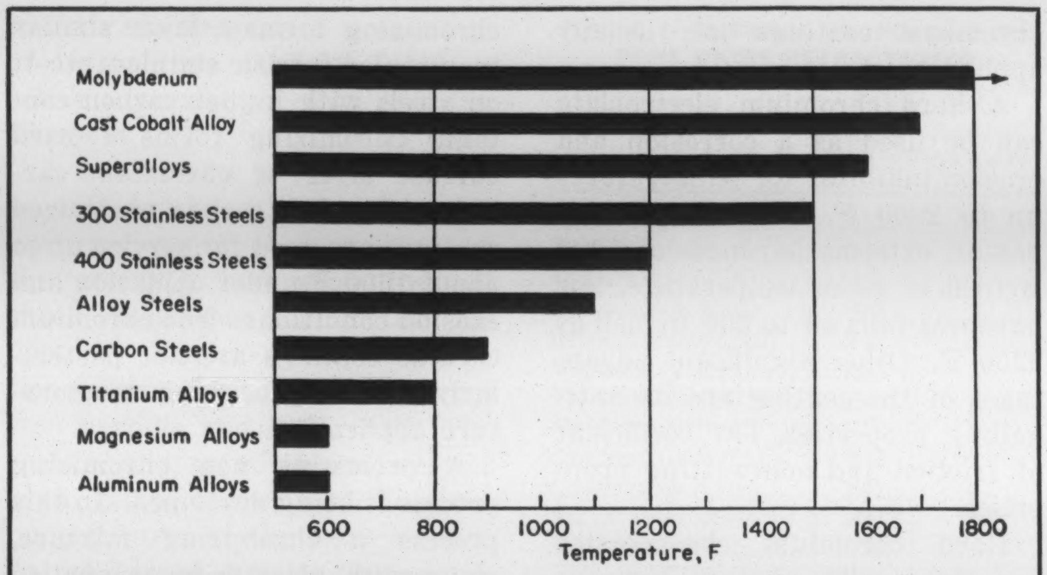
Nickel coatings can be applied to steel, aluminum, magnesium, titanium and other metals by a

TABLE 2—APPROXIMATE MAXIMUM USEFUL TEMPERATURES OF COATED METALS

Base Metal ➡	Aluminum Alloys	Magnesium Alloys	Titanium Alloys	Carbon Steels	Alloy Steels	400 Series Stainless Steels	300 Series Stainless Steels	Superalloys	Molybdenum
CERAMIC COATINGS									
Pure Oxide Refractories	650–w[b]	650–w[b]				1200–w	1600–c	1800–w	
	650–c[b]	650–c[b]				1200–c	1500–w	1800–c	
Mixed Oxide Refractories			1800–c[c]	1250–c	1250–c		1800–c	1800–c	
							1700–w	1700–w	
Tungsten-Cobalt					1000–w		1500–w	1500–w	
Nitrided Case				900–w	1000–w		1100–w	1100–w	
METAL COATINGS									
Pure Aluminum	650–c			900–c	900–c				
Calorized Aluminum				1400–c	1400–c				
Chromium Plate	650–w	650–w	800–w	900–w	1000–w	1200–w			
	650–c			1600–c	1700–c	1700–c			2000–c
Diffused Chromium				1600–c	1700–c	1700–c	1800–c		1500–c
Nickel Plate	600–w	600–w	1800–c	1600–c	1700–c				1600–c
Diffused Silicon				900–w	1700–c				2000–c
				1600–c					
Tungsten-Cobalt Alloy Plate				900–w	1000–w	1250–w			
				1500–c	1500–c	1500–c			
Stainless Alloys									1800–c
PAINTS									
Silicone (nc metal pigment)	650–c	650–c		700–c	700–c				
Silicone + Metal Pigment				1400–c	1400–c	1400–c			
Sodium Silicate + Metal Pigment				2000–c	2000–c	2000–c	2000–c		

[a] All temperatures in °F; c = temperature limit for corrosion protection; w = temperature limit for wear protection.

[b] Anodized. [c] Glass.



***Maximum temperature** limits (approx.) of various metals when loaded.*

Why Protective Coatings Are Needed

The ability of materials to withstand high temperatures is of paramount importance today. As shown in the accompanying graph, the maximum usable temperatures of the principal structural materials ranges from a low of 650 F for aluminum and magnesium to over 1800 F for molybdenum. Depending on operating conditions, some of these metals need no protection at all, whereas others require a high degree of protection because of their poor resistance to such environmental conditions as heat, oxidation, thermal shock, carburization, abrasion, corrosion or erosion.

There is no such thing as a universal protective coating. However, careful analysis of just what detrimental factors are and are not involved will usually point the way to the best coating for a given use.

variety of processes such as electroplating, electroless plating, spraying and vapor deposition.

Electroplated nickel can be applied from any of three types of baths. Electroless coatings are deposited by the auto-catalytic reduction of nickel salts. Because of their higher hardness and lower porosity, electroless coatings have proved better than electroplated coatings for high temperature applications. A further advantage of the electroless nickel process is its excellent throwing power and lack of current density problems. For applications where abrasion resistance is important, electroless nickel coatings retain good hardness up to 750 F, whereas nickel electroplates are not very useful above 500 F.

Both types of coatings are very resistant to corrosion and can provide oxidation resistance up to 2000 F for short periods. A typical high temperature use of nickel coatings is protecting titanium or molybdenum from oxygen contamination during forging or heat treating.

Silicon

Siliconized coatings on low carbon steels are obtained by heating steel in the presence of silicon carbide, or ferro-silicon, at 1750 F in an atmosphere of chlorine gas. The coatings consist of an iron-silicon solid solution containing about 14% silicon. They are chiefly noted for their resistance to scaling up to 1800 F in air, ductility up to the elastic limit of the base metal, low coefficient of friction, and resistance to galling and acid attack.

Coatings with a uniform silicon content and depth of 0.03 in. can be obtained after 2 hr of treatment. Because of their high hardness (about Rockwell B90), the coatings cannot be machined or cut. However, because of their uniform structure they can be ground to size with no sacrifice in properties.

Copper

Copper can be either electroplated or clad to form a protective coating. Because of the thickness required to overcome porosity, electroplated coatings provide little protection at temperatures over 500 F. Except as a stop-off barrier for nitriding or carburizing, their use at high temperatures is limited.

Copper-clad steel is produced by pouring copper around a steel ingot and then forming. Clad sheet and wire are available but their use above 500 F does not appear to be practical.

Silver

In all except special cases, use of silver is limited by its high cost. Silver electroplates have a very low coefficient of friction, exhibit excellent corrosion resistance up to 1400 F, and are used in conjunction with lead and indium for high speed aircraft bearings.

Tungsten

Tungsten cannot be plated by itself but has been successfully plated as an alloy of iron, nickel or cobalt. Of these, the tungsten-cobalt electroplate shows the most promise. The coating can be age hardened, and its hardness is comparable to that of Stellite. The aging cycle is very long; it consists of heating to 2200 F and then aging for 100 hr at 1100 F.

Corrosion resistance of the tungsten-cobalt plate at high temperatures is very good. Up to 1500 F the thermal expansion of the plate approximates that of steel base metals. However, above 1500 F expansion of the plate rises at such a rate as to cause plastic strain and give the plate a permanent set upon cooling. For this reason the coating is limited to operation below 1500 F. Hardness of age hardened coatings is 180 DPN at 1500 F, as compared to 53 DPN for unaged coatings at the same temperature.

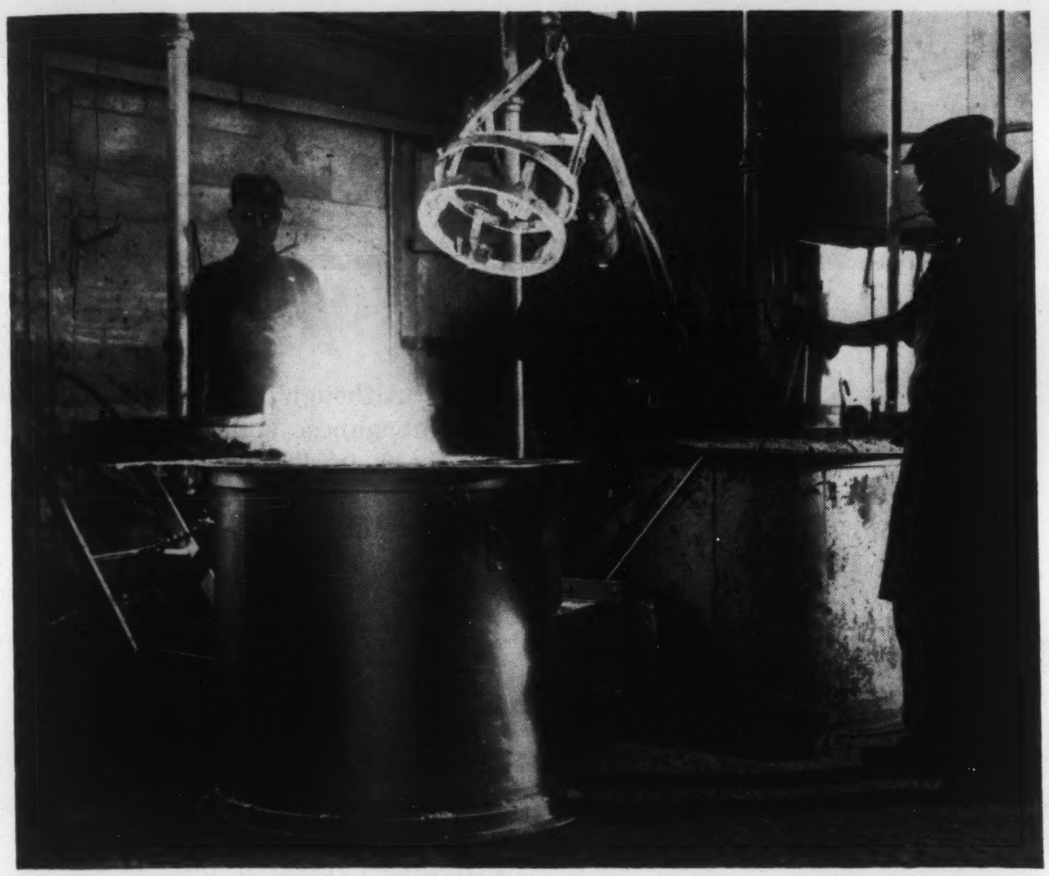
Since the production of age hardened tungsten-cobalt electroplates is quite expensive compared to other plating methods, such as chromium, this coating is not used to any great extent.

Molybdenum

Molybdenum coatings on steel or titanium can be applied by spraying. They can also be deposited from carbonyl vapor at 1000 F. In general, both types of coatings are limited to operation below 750 F, as molybdenum begins to oxidize rapidly above this temperature.

Stainless alloys

Both 18-8 stainless steel and some of the nickel-base alloys, such as Inconel, have been used as cladding materials for mild steel or copper plate. In most cases, the cladding is applied by welding or brazing. The claddings are used principally for their corrosion resistance at low to medium temperatures, particularly in such applications as chemical reactor vessels. Use of stainless alloy claddings (or sprayed coatings) at temperatures over 500 F is very limited.



Dow Corning Corp.

***Foundry furnace** (foreground) is coated on outside with silicone-aluminum paint to withstand temperatures exceeding 500 F.*

Special paints

are easy to apply and can often be used at temperatures over 1000 F.

Silicones

A number of silicone paints are available for protecting metal surfaces at temperatures above 500 F. In general, these paints consist of silicone resins or other inorganic binders plus a metal powder pigment. They are available with silicone contents ranging from 100% to as low as 5%.

The high silicone paints provide good protection at high temperatures. Commercial silicone baking enamels retain their film integrity at temperatures as high as 500 F—considerably higher than conventional paints.

Several metal-pigmented coatings have been developed that can be used as high as 1200 and even 1500 F. These coatings are heavily loaded with metal pigments such as powdered aluminum or zinc dust. The primary advantage of the silicone vehicle is that it provides protection to much higher temperatures than any organic resin can withstand. Upon prolonged exposure from 700 to 1000 F the silicone gradually volatilizes, but its matrix holds the pigment firmly in place. At higher temperatures the aluminum begins to diffuse into the base metal to produce a calorized surface. Such a coating may provide protection as high as 1500 F.

Metal-pigmented silicone coatings are used in a variety of medium and high temperature applications, including space heater combustion chambers, ovens incinerator interiors, mufflers and exhaust systems, electrical equipment, heat exchangers, high pressure steam lines, furnace casings, arc light reflectors and gas range shields.

Applications for jet aircraft and rockets are foreseen for an experimental coating consisting of silicone resin, ceramic frit and pigment. The coating reportedly can be used to 1000 F.

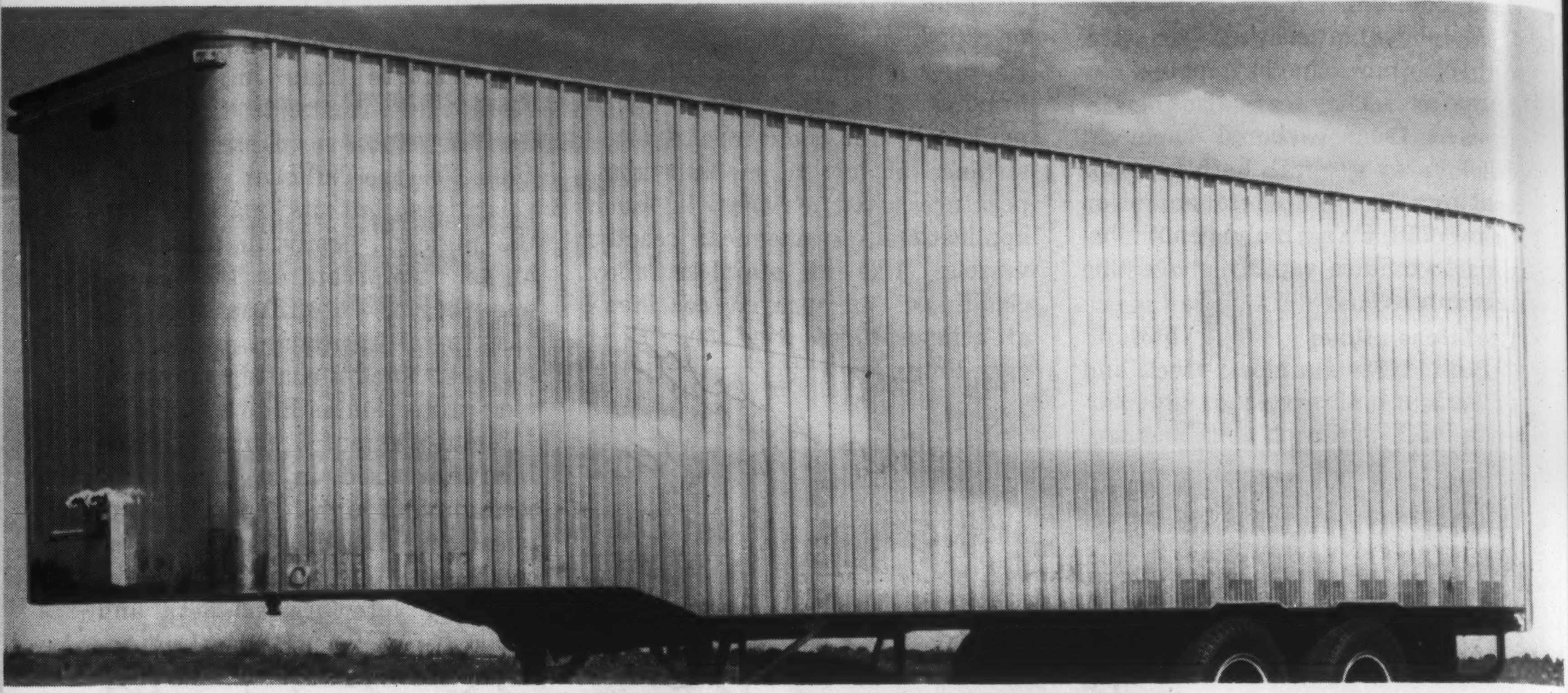
Sodium silicate

Stainless steel powders and sodium silicate (water glass) are combined in a baked coating that protects base metals against high temperatures, and oxidation and combustion products. The dried film, which is extremely hard and remains unchanged at 1500 F, welds to the base metal at 1700 F and will not flow at 2000 F. Principal applications of the coating are the sealing of firewalls in aircraft engine compartments, and protection of JATO exhaust tubes.

Besides stainless steel, powders of copper, nickel and chromium have been used in conjunction with sodium silicate. These coatings are used in the heat treatment of alloy steels both as an anti-seizing compound and for protection against carburization or decarburization.

Based on a paper presented before the High Strength High Temperature Materials for Standard Parts Symposium, Dallas, Tex., June '57.

These products were 18-8, are now made from the 200 series



Trailer truck body made by Budd Co.

How the 200 Series Compares with 18-8 Stainless Steel

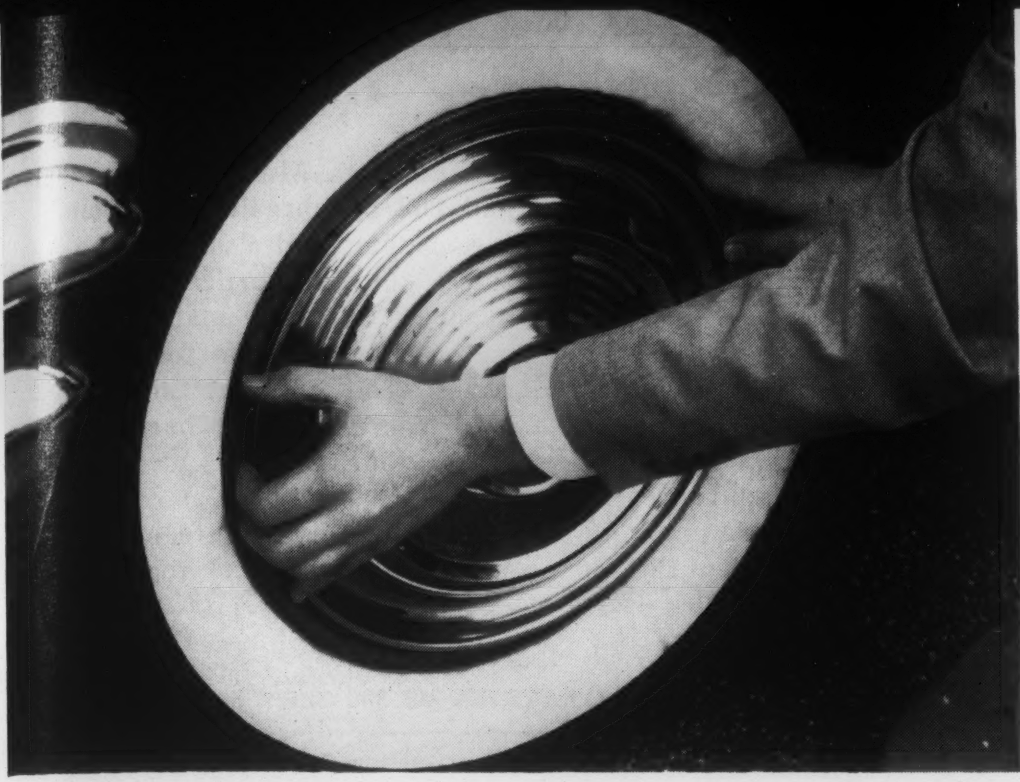
by George A. Sands and M. B. Keady,
Electro Metallurgical Co., Div. of Union Carbide Corp.

Although the chromium-nickel-manganese stainless steels have been in limited use for many years, they were only recognized as a new standard class, the 200 series, in 1955. Since that time, these steels have received wide acceptance. Production increased from 1900 tons in 1955 to about 25,000 tons in 1957; the 200 series were the only grades of stainless that showed a production increase last year.

Experience gained through continued research, testing, and use of the 200 series steels has proved that they are for the most part every bit as good as the steels for which they were once considered alternates. It has been variously estimated that 75 to 90% of the uses of 18-8, types 301 and 302, can be completely served by types 201 and 202.

TABLE 1—COMPOSITION AND TYPICAL MECHANICAL PROPERTIES OF ANNEALED SHEET

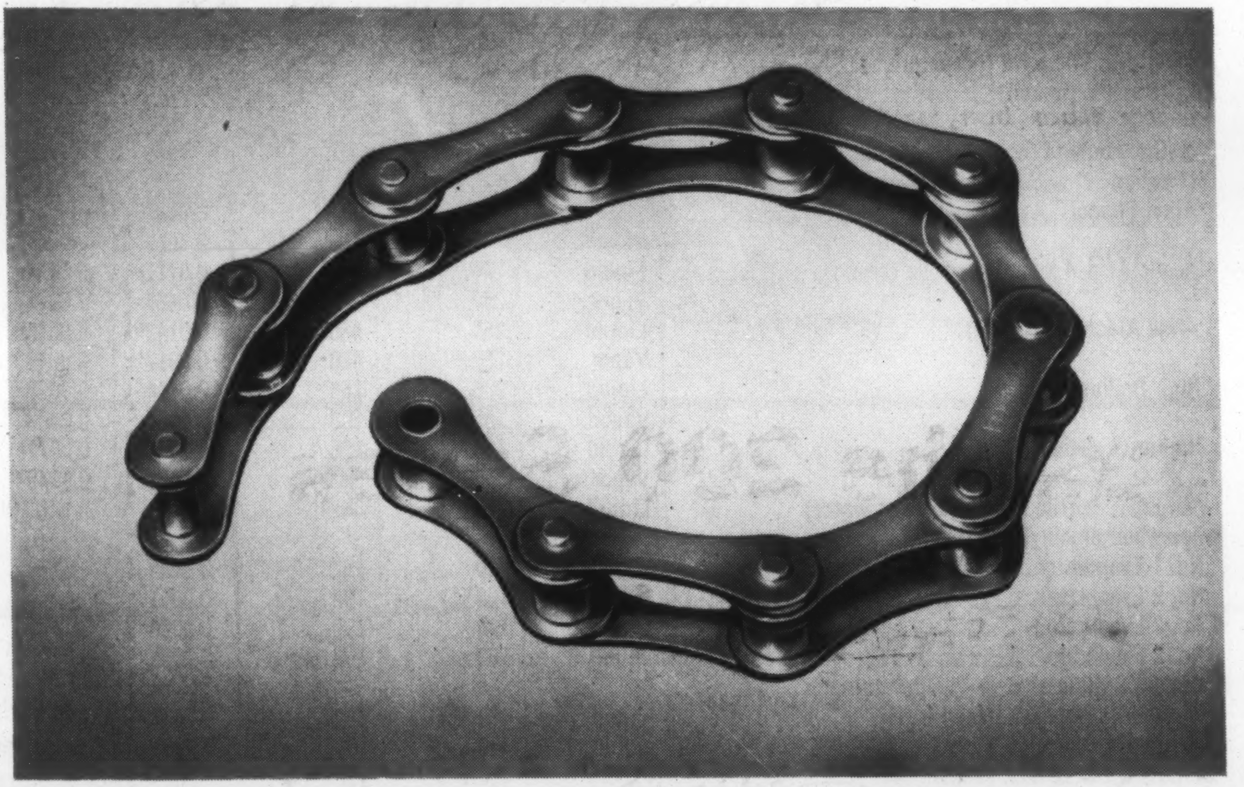
Type ⬇	Nominal Comp, %				Yield Strength (0.2% offset), 1000 psi	Tensile Strength, 1000 psi	Elong (2 in.), %	Rockwell Hardness
	Cr	Ni	Mn	C (max)				
201	17	4.5	6.5	0.15	55	115	55	B90
301	17	7	2.0 max	0.15	40	110	60	B85
202	18	5	8.5	0.15	55	105	55	B90
302	18	9	2.0 max	0.15	40	90	50	B85



Hubcap made by Delchrome, Inc.

Telephone drop wire clamp made by Reliable Electric Co.

Roller chain made by Marmon Products Co.



1. Strength is a little higher

Typical mechanical properties of the 200 series and corresponding 300 series steels are given in Table 1. All of these steels are fully austenitic. As shown in the table, tensile properties of the two series are comparable, although the yield strengths and hardnesses of the 200 series are somewhat higher. This increase in strength and hardness does not reduce the ductility, and in some applications the higher strength is advantageous. The standard strength ranges in which the 300 series grades are supplied can be duplicated in the 200 series.

2. Corrosion resistance is about equal

The 200 series steels are comparable with the corresponding 300 grades in atmospheric exposure and under oxidizing conditions. Investigation of the corrosion resistance of chromium-nickel-manganese grades in various industrial environments is still progressing. Some of the results of comparative tests of 200 and 300 grades are shown in Table 2. It is apparent that the 200 series steels are as resistant in many of these environments as types 304, 316 and 347.

3. Fabrication is comparable

Forming—In virtually all instances, the 200 series steels can be formed in the same manner and with the same equipment as the 300 series. In forming operations such as brake bending, draw-bench forming and roll forming, types 201 and 202 are identical with 301 and 302 excepting that a little more power is required because of the higher yield strengths. In some cases, lighter sections can be used because of the higher strength of the material.

Welding—The 200 series steels have good welding characteristics, and the welds exhibit high toughness at room as well as subzero temperatures. All welding procedures that have been found successful for the 300 series can be applied to the 200 series. Spot, seam, projection, inert gas and metal arc welding can be performed with ease, producing sound welds. Actually, the 200 series offers slightly increased resistance to intergranular corrosion (caused by carbide precipitation during welding) than the 300 series.

Finishing—Finishing types 201 and 202 by abrasive grit polishing, buffing and flash plating is easily and economically accomplished. The same materials and methods are used as for the 300 series. The fact that the 200 series steels are slightly harder than other grades should simplify polishing somewhat. In as-rolled finishes and general surface appearance the steels are similar to the corresponding type 300 alloys.

TABLE 2—CORROSION RATES OF STAINLESS STEELS: 200 SERIES VS 300 SERIES

Environment	Exposure			Corrosion Rate, in./year				
	Phase	Approx Temp, F	Time, hr	Chromium-Nickel			Chromium-Nickel-Manganese	
				Type 304	Type 316	Type 347	Type 202	Type 201
Agricultural Chemical (preparation)	Liquid	—	528	—	Nil	—	—	0.2728
Alkyl Amines (mixed)	Liquid	212	744	Nil	Nil	Nil	Nil	—
	Vapor	212	744	Nil	Nil	Nil	Nil	—
Dimethoxybutane (crude)	Liquid	265	48	0.0002	0.0002	—	0.0003	—
Distillation								
Alkyl Phenol	Liquid	400	1080	0.008	—	—	—	0.0016
	Vapor	400	1080	0.002	Nil	—	—	0.0002
Acetic Acid-Acetic Anhydride (crude)	Liquid	240	2736	0.0711^c	0.0134	0.0843	—	0.1041
	Vapor	230	2736	0.0485^c	0.0174	0.0733	—	0.0675
Alkyl Aldehyde (crude)	Liquid	265	480	0.0142^a	0.0045^a	—	—	0.0163^c
	Vapor	250	480	0.0917^b	0.0043^b	—	—	0.0647
High Boiling Ketone	Liquid	285	163	0.0134	0.0020	—	0.0361	—
	Vapor	265	208	0.0026	0.0003	—	0.0090	—
Higher Organic Anhyride	Liquid	410	156	0.0474^c	0.0072^a	—	0.0226^b	0.0304^a
	Vapor	355	322	0.0071	0.0045	—	0.0002	—
"Organo"-Nitrile (in presence of water)	Liquid	220	3624	Nil	Nil	—	Nil	Nil
Evaporation of Alkyl Sulfate								
No. 1 Evaporator	Vapor	120	192	0.0083	—	—	0.0179	—
No. 2 Evaporator	Vapor	160	192	0.0001	—	—	0.0001	—
No. 2 Evaporator	Liquid	120	192	0.0086	—	—	0.0183	—
No. 2 Evaporator	Liquid	160	192	0.0001	—	—	0.0002	—
Hydrogen Sulfide at High Temperature								
Middle Oil Dist. Sys. (feed tray)	Liquid	480-645	1296	0.0453^c	0.0263^a	—	—	0.0155^a
Middle Oil Dist. Sys. (tray No. 2)	Liquid	480-645	1016	<0.0001	<0.0001	—	—	<0.0001
Middle Oil Dist. Sys. (vent)	Vapor	480-645	1224	Nil	—	Nil	—	Nil
Light Oil Dist. Sys. (top of col)	Liq-Vap	300-680	2415	Nil	Nil	—	Nil	—
Heavy Oil Dist. Sys. (top of col)	Liq-Vap	570-645	2415	Nil-0.0005	Nil	—	Nil	—
Dewatering Still Kettle	Liquid	250	2415	Nil	Nil	—	Nil	—
Product Storage Tank (vapor space)	Vapor	Ambient	1224	Nil	—	Nil	—	Nil
Organic Acid, Unsaturated (preparation)	Liquid	—	696	Nil	Nil	—	—	Nil
Oxidation of Aldehyde to Organic Acid	Liquid	140	161	0.0007	Nil	—	—	0.0002
Purge of High Boiling Ether with Hydrogen Chloride	Liquid	212	23	0.0050	0.0046	—	—	0.0062
Reaction								
Esterification with Sulfuric Acid Present	Liquid	195	24	—	0.0329	—	0.9970	—
Esters Using Unsat. Organic Acid with Sulfuric Acid	Liquid	—	154	0.0013	Nil	0.0016	0.0002	Nil
Mixed Esters	Liquid	250	750	Nil	—	Nil	—	Nil
Hydrocarbon-Carbon Dioxide	Liquid	300	312	Nil	Nil	—	Nil	—
	Vapor	260	312	Nil	Nil	—	Nil	—
	Liquid	285	336	Nil	Nil	—	Nil	—
	Vapor	212	336	Nil	Nil	—	Nil	—
Organic Amino Sulfate	Liquid	195	81	0.0231	0.0137	—	0.0190	—
Storage								
Agricultural Chemical Water Sol'n	Liquid	Room	312	Nil	—	—	—	Nil
High Boiling Ether-Hydrogen Chloride Sol'n (dry)	Liquid	Room	312	0.0064	0.0017	—	—	0.0048
High Boiling Ether-Hydrogen Chloride Sol'n (wet)	Liquid	Room	216	0.0068	0.0035	—	—	0.0030
Insecticide Water Sol'n	Liquid	Room	113	Nil	—	—	0.00 1	—
Organic Fluoride	Liquid	32	1600	0.0006	0.0003	—	0.0010	—

[a] Average of four exposures. [b] Average of two exposures. [c] Type 304L.

Test panels *of chromium-nickel-manganese stainless steels have been exposed to atmospheric corrosion for 25 years.*

Development of the 200 Series

The chromium-nickel-manganese stainless steels, designated recently as the 200 series by the American Iron & Steel Institute (AISI), are based on research started more than 25 years ago by Electro Metallurgical Co. It was discovered that a fully austentitic steel containing at least 16% chromium requires only 4% nickel for optimum corrosion resistance under oxidizing conditions. As a result, a series of austenitic steels was developed in which manganese and nitrogen replaced approximately half the nickel. This combination of elements helps maintain the austenitic structure; the corrosion resistance is provided by the chromium and nickel content. Test samples of these early steels, placed in racks for atmospheric corrosion tests in 1932 in New York City are still in excellent condition after 25 years of exposure (see left).

4. Cost is less—availability, better

The 200 series steels have a definite price advantage over the 300 series steels. Although the difference amounts to only about 1½¢ per lb for the directly comparable grades (201 vs 301 and 202 vs 302), the difference becomes significant with other grades. For example, type 202 in rod form averages 5¢ per lb less than type 304. In sheet form, the differences are considerably greater.

The present availability of nickel is expected to have little bearing on the acceptance of the 200 series. In times of high productivity and because of the many important nickel-containing strategic alloys, the metal could again become critical. Manganese, on the other hand, is readily available.

Typical Products Made of the 200 Series

Automobile roofs and trim
Automobile wheel covers
Beer barrels
Cable terminal ground strips
Capacitor cases
Cheese hoops
Coal chutes
Coffee makers
Cookware
Cooling coils
Cream separator disks
Dairy tank trim
Dial springs
Dispensary cabinets
Door push plates
Doorknobs, locks and pulls
Doors
Drinking cups
Dry blenders
Electric range burner supports
Electrical service wedge clamps
Elevator panels
Flatware
Fruit juice extractors
Hospital cups
Ice machine parts
Kitchen sinks
Kitchen tools
Milk cans
Milk-holding tanks
Milking machine parts
Mixing bowls
Orange juice tank truck linings
Ornamental tubing
Paper towel dispensers
Pipe couplings, clamps and joints
Piston ring expander-spacers
Playground slides
Range hoods
Refrigerator doors
Rotisseries
Safety belt hardware
Shoe fasteners
Soda fountain mixing cups
Steam and dry iron parts
Syrup containers
Table tops
Tea kettles
Trailer truck bodies
Wash fountains
Washing machine parts
Window frames and flashings
Windshield wiper blades

SILICONES vs OTHER FLUIDS: HOW THEY RATE . . .

	Lubricity			Thermal Stability	Oxidation Stability	Viscosity-Temperature Characteristics
	212 F	300-400 F	500-700 F			
Better Fluids ➡	Petroleum; diesters; chlorinated biphenyls; orthosilicates; **Versilube 81717**; polyglycol	Diester; chlorinated biphenyls; orthosilicate; petroleum; **Versilube 81717**; polyglycol	**Versilube 81717**; some petroleum with additives	Silanes; silphenylenes; chlorinated biphenyls; polynuclear aromatics	Chlorinated biphenyls; silanes; methyl-phenyl silicones; polynuclear aromatics	Methyl silicones
ILICONE FLUIDS ➡	⟵ VERSILUBE F-50 ⟶					
Poorer Fluids ➡	Silanes; polynuclear aromatics; methylphenyl silicones; methyl silicones	Silanes; polynuclear aromatics; methylphenyl silicones; methyl silicones	Diesters; petroleum; chlorinated biphenyl	Petroleum; diesters	Diesters; orthosilicates; petroleum; polyglycol	Petroleum; polyglycol; diester; orthosilicate
Much Poorer Fluids ➡			Polynuclear aromatics; orthosilicates; polyglycols; silanes; methylphenyl silicones; methyl silicones	Polyglycol; orthosilicates	Some petroleum	Chlorinated biphenyls; silanes; polynuclear aromatics

New | Lubricants Hydraulic Fluids for High Temperatures

by **E. D. Brown, Jr.**, *Silicone Products Dept., General Electric Co.*

Three new silicone fluids can be used as hydraulic fluids and lubricants over a service temperature range of –65 to 700 F.

■ The importance of these new fluids, trademarked Versilubes, lies in a compromise of properties. Though many other lubricants and hydraulic fluids are superior to the silicones in several individual requirements, no other fluid offers the favorable compromise that the silicones do in the critical properties required for operation at extreme temperatures.

The new fluids are chlorophenyl-containing methyl silicones. A family of three fluids has been developed to meet the differing property requirements of engine lubricants and hydraulic fluids. Each fluid has specifically tailored properties. Versilube 81717 provides maximum lubricity, F-50 provides maximum thermal stability, and 81644 has maximum oxidative stability.

Lubricity

Lubricity is the primary requirement of engine oils and the second most important requirement of hydraulic fluids (see pie charts). Lubricity has always been one of the poorer characteristics of silicone fluids in general. Where service temperatures are within the range of conventional lubricants, applications for silicones are limited to those requiring good viscosity-temperature ratios and/or chemical inertness. As service temperatures increase, the relative lubricity of silicones improves substantially. This improvement is shown in the table which compares various lubricants with F-50, the general purpose Versilube, over various temperature ranges.

At 212 F, lubricity of the silicones is relatively poor. From 300 to 400 F Versilube 81717 becomes, by comparison, a much better lubricant than the other fluids. In the 500 to 700 F range those fluids which were not particularly good lubricants at the lower temperatures have not improved; those which were merely acceptable have become unusable. The only fluids with sufficient lubricity for service over this temperature

. . AND HOW THEY COMPARE

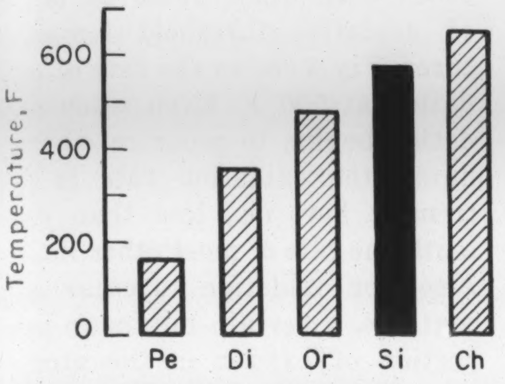


Fig 1—Thermal threshold.

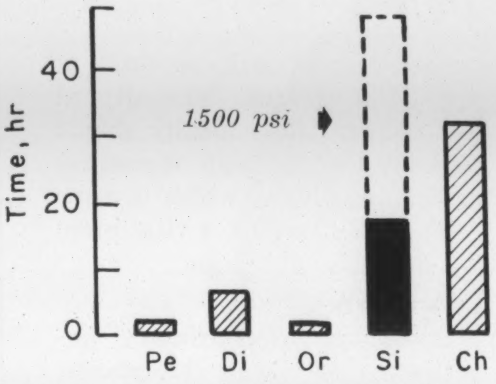


Fig 2—Useful life at 700 F.

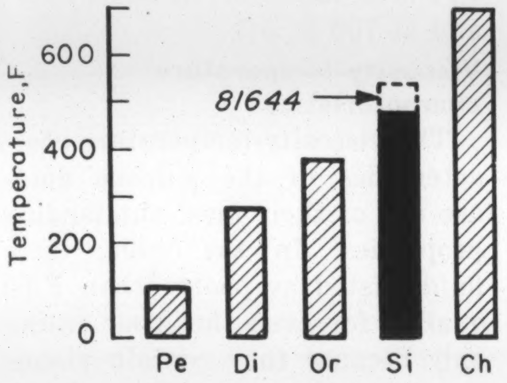


Fig 3—Oxidative threshold.

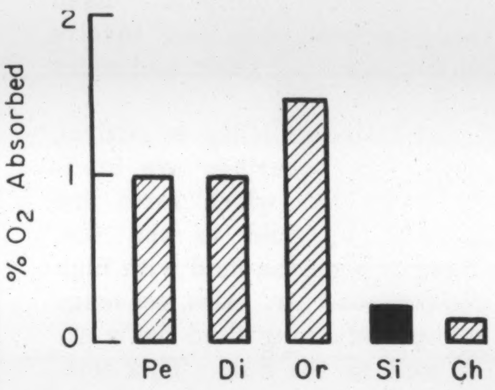


Fig 4—Oxidation rate at 500 F.

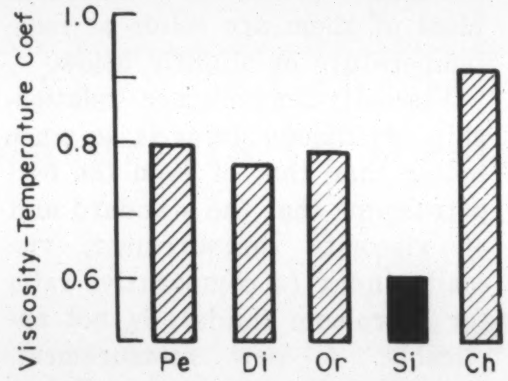


Fig 5—Viscosity-temperature.

KEY:
Pe = petroleum
Di = diester
Or = orthosilicate
Si = silicone (Versilube)
Ch = chlorinated aromatic

range are F-50, 81717 and some petroleum lubricants with additives.

Measurements of lubricity depend on the tests used; results here are based on wear and load-bearing tests. For actual wear prevention all of the Versilube fluids are satisfactory at all temperatures, though the load limit for F-50 is not particularly high (about 40 kg at 212 F) and drops with temperature. Fluid 81717 will carry loads as great as 120 kg at 212 F and 40 kg at 700 F with the same wear-preventing characteristics as those of F-50.

Thermal stability

For most fluids, thermal stability and oxidative stability represent the same characteristic. With silicone fluids, they are actually two different properties because of the dual role of the silicone molecule as both an organic and inorganic material.

Under strictly thermal conditions (i.e., heat but no oxidative conditions) the silicone molecule is attacked at the inorganic section and like all polymers tends to assume its lowest energy state —in this case the cyclic trimer. Fortunately, the product of thermal breakdown (the cyclic trimer) is nontoxic, non-abrasive, volatile at 700 F and soluble at room temperature.

The table on p 124 compares the thermal stability of F-50 fluid with that of other fluids. The only materials with better thermal stability than F-50 are those which are unusable because of their viscosity-temperature characteristics and their poor lubricity. The thermal threshold temperature (the maximum temperature at which no thermal degradation occurs) for the silicone fluids is 600 F. Maximum operational time at high temperature is 12 hr at 700 F at atmospheric pressure, or 50 hr at 700 F under 1500 psi pressure.

Fig 1 compares the thermal stability (in terms of thermal threshold temperature) of the silicones with four other lubricants. Beyond the 600 F absolute stability temperature of silicones, usefulness of the fluids is limited by factors such as time or temperature. These factors can be used to define practical stability. Fig 2 compares the useful life of the silicone fluids at 700 F with life of other lubricants. Breakdown rate for silicones increases with temperature to a rate of 2% per hr at 700 F.

Thermal stability of silicone fluids is actually promoted by the conditions under which a hydraulic system operates, i.e., pressures up to 5000 psi. Pressure reverses the reaction of the fluid that forms the cyclic trimer; at pressures above 1500 psi the long chain polymer is reformed.

Oxidative stability

Under oxidative conditions the organic portion of the silicone molecule is attacked, removing the methyl side unit in a reaction forming formaldehyde. The reaction leaves an oxygen crosslink which increases the viscosity of the fluid. The temperature at which this reaction starts is called the oxidation threshold temperature. The accompanying table compares the composite oxidative stability of F-50 with that of other fluids. The only fluids better than the silicones are those which are unusable from other standpoints.

The oxidative threshold temperature for F-50 is 430 F; for

81717 it is 450 F, and for 81644 it is 510 F. Fig 3 compares silicones with other fluids in terms of oxidative threshold temperatures. Fig 4 shows the rate of oxidation at 500 F. Even when oxidation begins to occur in silicone fluids, the oxidation rate is extremely low, i.e., less than one-tenth the rate of most other fluids. Also, for oxidation to occur and continue, a certain minimum proportion of oxygen in the atmosphere is required. For F-50 at 500 F, 9% is required; at 600 F, 7%; and at 700 F, 5%.

Viscosity-temperature characteristics

The viscosity-temperature characteristics of the silicone fluids are one of their most outstanding properties. In the table, those fluids listed as poorer than F-50 qualify for even this poor rating only because they contain viscosity index improvers. Those listed as much poorer are unusable. Most of them are solids at room temperature or slightly below.

Viscosity-temperature relationship of silicone fluids is so much better than that of even the best petroleums that the standard unit of viscosity measurement, viscosity index (a comparative ratio for petroleum fluids), is not applicable. A new measurement, viscosity-temperature coefficient (VTC) has been devised. It is computed as follows:

$$\text{VTC} = \frac{\text{visc at 100 F} - \text{visc at 212 F}}{\text{visc at 100 F}}$$

The lower the VTC value, the better the fluid's viscosity-temperature relationship for lubrication and hydraulic use. All the Versilube fluids have the same VTC value—about 0.60. Fig 5 compares the VTC of silicone fluids with that of several other fluids.

Absolute viscosities of fluids at low temperatures are important in design of hydraulic systems since they affect the size of lines and thus the weight of the system. The silicone fluids come the closest of any hydraulic fluids to meeting the requirements of aircraft designers in this regard.

What Properties Are Important?

There is a similarity in the properties required of high temperature engine lubricants and high temperature hydraulic fluids. However, the relative importance of the properties differs substantially for the two uses (see accompanying pie charts).

There are six critical properties—three for hydraulic fluids, three for lubricants—which must meet design requirements. Deficiencies in these basic properties cannot be compensated for by variations in equipment design. In descending order of importance they are: for hydraulic fluids, 1) thermal stability, 2) lubricity and 3) good viscosity-temperature characteristics; for lubricants, 1) lubricity, 2) oxidative stability and 3) thermal stability. The importance of these properties can better be understood when the conditions of the systems in which the fluids operate are understood.

Hydraulic fluids

Hydraulic fluids operate in a sealed system and can be kept from contact with oxidizing atmospheres. Thus resistance to breakdown caused by heat, not oxidation, is critical. Hydraulic fluids must also have sufficient lubricity to prevent galling, tearing and excessive wear of pump parts, servos, actuators and minor equipment.

Viscosity characteristics of the fluid must be such that it can be pumped under pressures as high as 5000 psi at high temperatures and still be fluid at low temperatures. Viscosity at low temperatures ideally should be kept low, as high viscosities mean large lines, which in turn mean added weight, a vital problem in aircraft design.

Lubricants

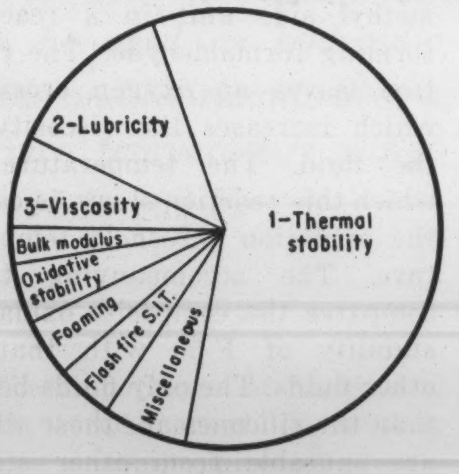
Lubricity is of primary importance in engine lubricants, since lubricity failure can result in immediate disaster. Load bearing conditions can involve sliding contacts, gears and roller and ball bearings.

Oxidative stability is critical, since large bearings are lubricated by jets which force fine streams of fluid to the surfaces, mixing the fluid with high temperature air. Also, scavenge pumps returning fluid draw air as well as the fluid. This combination of continuous and unavoidable exposure to air plus high temperatures and agitation creates ideal conditions for oxidation degradation. This degradation creates cokes, varnishes and sludges which can plug or reduce orifice openings and imperil bearing surfaces.

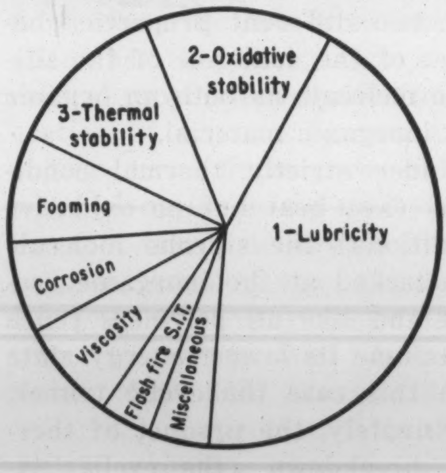
Where "throw away" systems are not possible, thermal stability must be sufficient to allow mission completion.

Hydrolytic stability

Hydrolytic stability is another important property of fluids for hydraulic or lubrication service. Nothing surpasses the silicones in resistance to chemical reaction with water; they will not form sludges, acids or gels.



Hydraulic fluids (−30 to 700 F)



Engine oils (−65 to 700 F)

16
Winning Entries
"Best Use of
Materials"
Competition

1957-58 ANNUAL

Materials in Design Engineering

Awards Competition

for the Best Use of Materials in Product Design

■ ABOUT THE COMPETITION The object of this competition, begun last year, is to encourage sound, imaginative and progressive use of engineering materials in the design and redesign of industrial and consumer products. The editors of this magazine impose no rigid restrictions on the procedures or criteria used by the judges in determining the award winners. However, the following factors are certainly among the most important ones: 1) importance of materials selection in the design, 2) degree of competence and thoroughness shown in materials selection, 3) degree of success achieved in meeting service requirements or improving old design, and 4) significance of entry in terms of setting new trends in use of engineering materials. In order to insure fair consideration of entries requiring a smaller scale of design and development than major entries, the judges split all entries into two groups, depending upon their complexity, and evaluated each group separately. Therefore, the award winning products discussed on the following pages cover a wide range of size and complexity. ***The complete list of award winners appears on page 142.***

Tailpipe *made from 0.002-in. type 321 stainless steel sheet welded to No. 1 corrugation of the same material. The cylinder is stiffened radially by ring bands of steel 0.030 in. thick and ⅜ in. wide spaced about 2 ft apart on centers. This design weighs 14.7 lb, compared to 35 lb for earlier design; weight saving is 58%.*

Paper-Thin Steel Sheet Cuts Weight of Aircraft

Background

In the summer of 1954 Ryan Aeronautical Co. began a study of airplane structure having good stiffness and the good high temperature characteristics needed for supersonic flight. A weight penalty was expected and considered justifiable in order to achieve satisfactory structure.

During this study, Ryan tried to achieve the desired rigidity by means of honeycomb, foam, posts and closely spaced stiffeners. In every case, the weight penalty appeared to be too severe; as a result, the study quickly became a battle to reduce weight.

In minimizing weight, all of the structure must be considered. Such things as joints, attachments, glue and excessive core material add weight (for example, a single glue line alone is equivalent to a sheet of aluminum 0.006 in. thick).

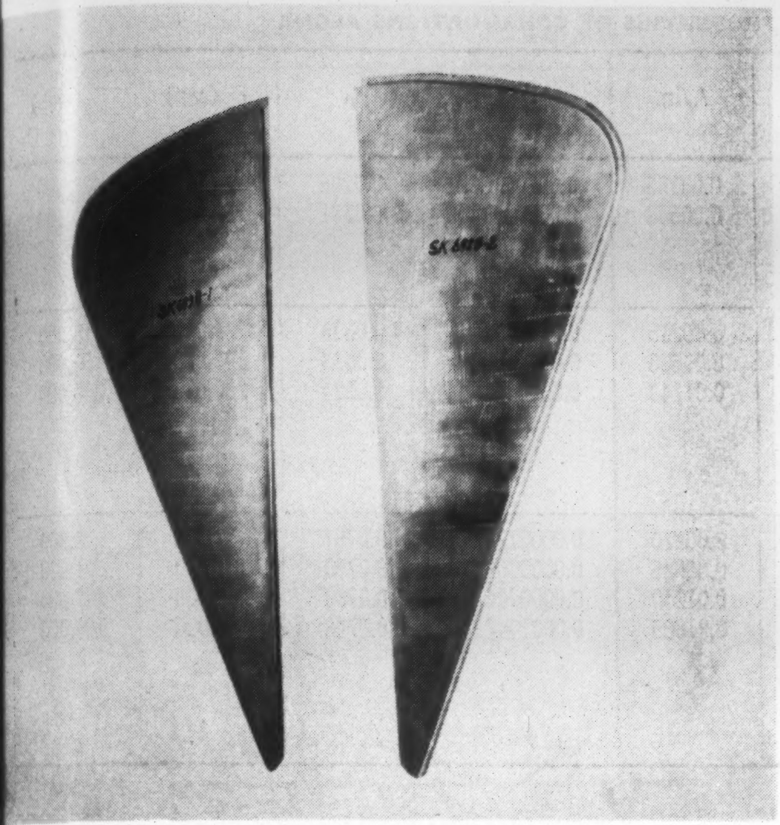
Among the promising concepts abandoned were resistance welded honeycomb and a sandwich material with cone shaped posts. Unlike the skin-corrugation concept described in this article, these materials failed to meet two important criteria established by Ryan: 1) the material must work to a stress near its yield strength in light load areas, and 2) it must carry the same basic design into the high load structure.

■ Aircraft structures that are strong, yet much lighter than heretofore, are the result of a new design concept developed by Ryan Aeronautical Co. The concept utilizes thin steel foil—on the order of 0.001 to 0.005 in. thick—stiffened locally with miniature corrugations joined to it by spot welding.

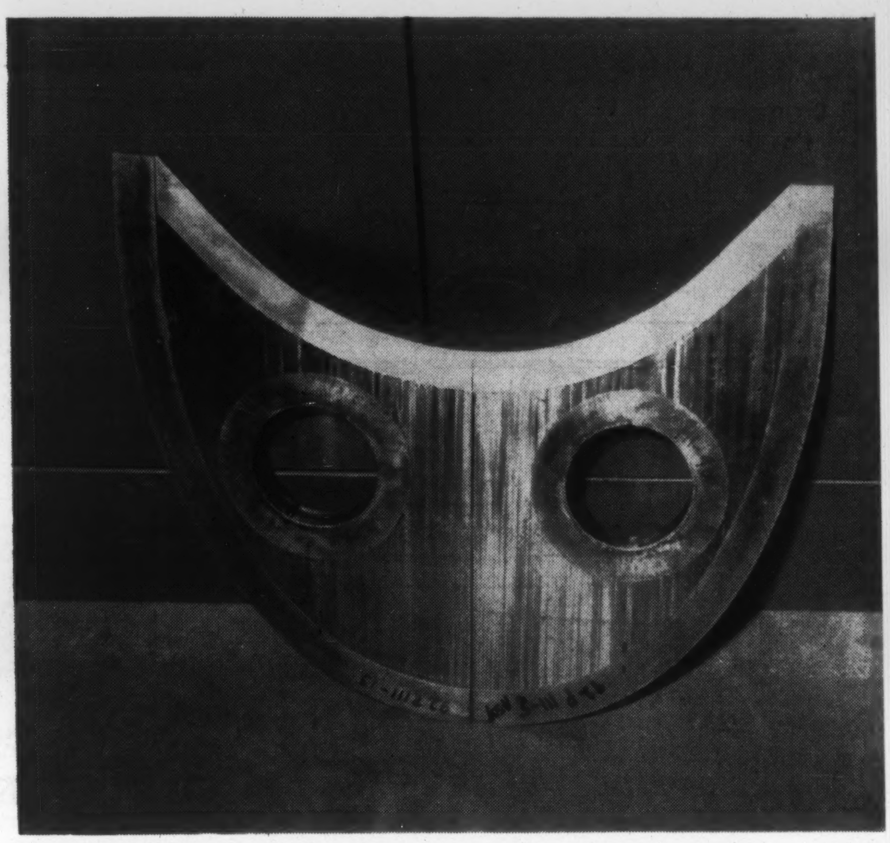
This new type of design grew out of a search by Ryan for an aircraft structure with good stiffness and good high temperature characteristics — a search that quickly evolved into a battle to reduce weight (see accompanying box).

Objectives and results

According to Bruce Mitchell, Ryan's structure chief, the only way to make a weight comparison between the skin-corrugation type of design and the more conventional skin-stringer or honeycomb designs is to compare direct calculations of the total material used in comparable designs intended for the same purpose. The designer can be sure weight is a minimum if the design 1) uses a



Panels *have Zee stiffeners made from 0.006-in. 17-7PH steel welded to 0.010-in. 17-7PH steel skins at spacings of ⅝ to 1¼ in. These panels were formerly made with brazed honeycomb. Weight saving is 18%.*



Firewalls *made from 0.002-in. type 321 stainless steel sheet welded to No. 1 corrugation made from the same material. Original plan called for 0.016-in. firewall. Weight saving is 60%.*

First Award

RYAN AERONAUTICAL CO.

material that has a high strength-weight ratio, 2) develops stresses near the yield strength of the material, 3) achieves a taper effect in material that matches the applied load for the primary structure, and 4) uses a supporting structure containing the least material needed to prevent buckling of the primary load members.

Ryan has made design studies on existing structures following the methods outlined in this article. In every case a large saving in weight was easily made; in several cases, weight was cut in half. These studies included structures formerly designed for aluminum, titanium and steel. Some of these parts have been built and are shown in the accompanying photos.

Why steel?

Designing for minimum weight requires that much of the material be extremely thin. Steel is the only high strength material presently available in extremely thin sheet; it can be rolled into sheets as thin as 0.001 in.

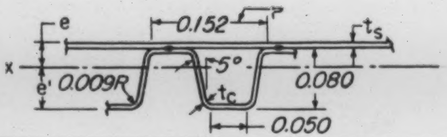
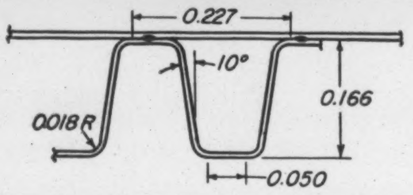
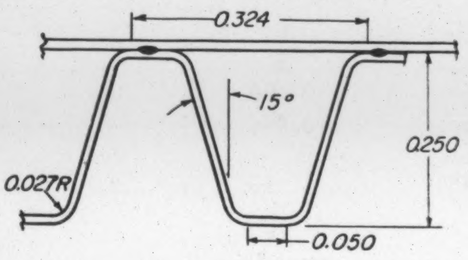
Although a number of steels are satisfactory, precipitation hardening stainless steel 17-7PH is particularly desirable for use as thin sheet because it can be heat treated without scaling. Moreover, it has good high temperature properties, it has exceptionally good forming and welding characteristics, and it is relatively cheap. Annealed at 1750 F, this alloy has 45,000 psi yield strength and 35% elongation. Precipitation hardened and aged at 950 F, it has 200,000 psi yield strength, 240,000 psi tensile strength and 5% elongation.

Fig 1 compares 17-7PH on a strength, weight and temperature basis with 6Al-4V titanium alloy, 7075 aluminum alloy and HK31XA magnesium alloy. This comparison is made with compression yield as a limit because that is the major design limitation. The chart shows that if the steel were to match the strength-weight ratio of titanium at room temperature it would have to have a yield strength of 250,000 psi—considerably above its actual strength. Although 17-7PH falls short at room temperature, the difference in strength-weight ratio between it and titanium becomes less as temperature increases. At 700 F, where the steel has a yield strength of 160,000 psi, the two materials are about equal. Moreover, much of the theoretical advantage of titanium at room temperature is lost because of practical considerations: the titanium alloy is not available in sheets thinner than 0.025 in., it is not easily welded or formed, and it is initially very expensive.

Why corrugations?

A room temperature yield

PROPERTIES OF CORRUGATIONS ALONE

Corrugation No ↓	t_c	P	A/in.	I/in.	ρ	F_c (cap)	F_c (web)
1  e 0.152 P t_s x 5° e' 0.009R t_c 0.080 0.050	0.001	0.152	0.00185	0.000001508	0.0285	32,000	24,000
	0.003	0.152	0.00548	0.000004340	0.0281	290,000	230,000
2 	0.001	0.227	0.00215	0.00000618	0.0536	21,000	15,000
	0.003	0.227	0.00633	0.00001800	0.0533	191,000	50,000
	0.006	0.227	0.01243	0.00003415	0.0524	200,000	200,000
3 	0.001	0.324	0.00210	0.0000123	0.0767	17,000	2,300
	0.003	0.324	0.00626	0.0000362	0.0760	151,000	21,000
	0.006	0.324	0.01240	0.0000704	0.0753	200,000	87,000
	0.009	0.324	0.01868	0.0001047	0.0748	200,000	199,000

The Corrugations: Design and Properties

Design

The design of the miniature corrugations was a compromise between theoretical and practical considerations:

1. Symmetry of the corrugations is necessary for the details of structural assembly.
2. The 0.050-in. width of the flat face was dictated by welding requirements.
3. Tests indicated enough fixity in the corners to permit a K factor of 5.3 in the buckling formula.
4. Corrugation depth was determined by the requirement for non-buckling up to 200,000 psi stress.
5. Pitch was based on the non-buckling limits of a skin

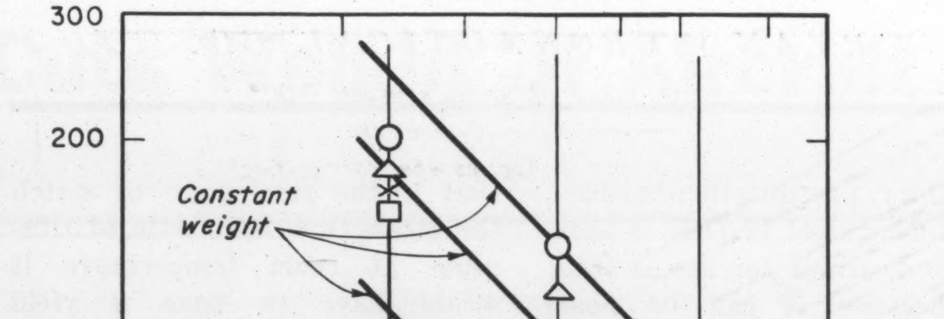


Fig 1—Strength-weight-temperature comparison of four materials with compression yield strength as the limit.

strength of 200,000 psi means that a strip of 17-7PH 1 in. wide and 0.001 in. thick can carry an axial load of 200 lb. In order to exploit the full strength of the material it was necessary to devise ways of 1) stabilizing the sheet for compression loads of this magnitude, or 2) collecting the load and concentrating the material until stabilization is possible.

Tests showed that the buckling formula $F_{CR} = KE\,(t/b)^2$ holds true for thicknesses at least as low as 0.002 in. Calculations indicated that if, for example, non-buckling at a stress of 200,000 psi was desired in a 0.004-in. skin, stiffeners could not be spaced more than 0.09 in. Since practical considerations rule out the use of individual stiffeners spaced closer than ⅜ in., it was necessary to consider use of miniature corrugations. Three standard corrugations were developed, as explained in the box above.

PROPERTIES OF CORRUGATION WITH SKIN

t_s	t_c	A/in.	e	e′	$I_{x\text{-}x}$/in.	$\rho_{x\text{-}x}$	F_c (skin)
0.001	0.001	0.00285	0.0268	0.0533	0.00000257	0.0300	4,500
0.004	0.002	0.00768	0.0221	0.0583	0.00000634	0.0287	72,000
0.007	0.003	0.01248	0.0227	0.0580	0.00001016	0.0286	200,000
0.001	0.001	0.00315	0.0575	0.1095	0.0000108	0.0585	2,000
0.004	0.002	0.00824	0.0457	0.1243	0.0000267	0.0570	32,000
0.008	0.004	0.0164	0.0473	0.1267	0.0000539	0.0573	130,000
0.009	0.005	0.0194	0.0514	0.1236	0.0000660	0.0583	164,000
0.010	0.005	0.0204	0.0499	0.1261	0.0000699	0.0585	200,000
0.001	0.001	0.00310	0.0855	0.1655	0.0000230	0.0862	1,000
0.004	0.002	0.00819	0.0672	0.1868	0.0000573	0.0837	16,000
0.008	0.004	0.01632	0.0695	0.1885	0.0001155	0.0840	64,000
0.010	0.005	0.0204	0.0713	0.1887	0.0001452	0.0844	100,000
0.012	0.006	0.0244	0.0727	0.1893	0.0001751	0.0847	144,000
0.014	0.007	0.0284	0.0738	0.1902	0.0002048	0.0850	196,000
0.016	0.008	0.0324	0.0755	0.1905	0.0002372	0.0855	200,000

of twice the thickness of the corrugation material.

6. Practical considerations required that the number of standard sizes be limited. Corrugation No. 1 has a top gage limit of 0.003 in., No. 2 a gage limit of 0.006 in., and No. 3 a limit of 0.009 in. Corrugations larger than No. 3 are not desirable because stiffeners become practical for stiffening sheet above 0.016 in.

Properties

The above table gives the allowable buckling stress in the web, as well as the section properties, for the thinnest and thickest of each of the three standard types of corrugations. It also gives the section properties of some typical skin-corrugation combinations for each of the three types of corrugations.

Design of structure

Covering—The corrugations are too shallow to have the good column characteristics necessary to resist pressure loads, and in most cases it is not practical to provide enough supports to reduce column length to the extent needed for high stress. However, the combination of miniature corrugations welded to thin skin has good bending stiffness in one direction and can be used very effectively to beam the pressure loads to the spars.

Allowable pressure loading for the various skin-corrugation combinations has been calculated from section data such as that shown in the box (p 130). This pressure loading is based on a unit width of beam parallel to the corrugations and passing over many supports. Maximum moment at midspan and over the supports is: $M = WL^2/12$, where W = load, psi; L = length of span, in. Results of these calculations have been assembled graphically, making it possible to determine quickly the required spar spacing for any combination of pressure load, corrugation type, skin gage and corrugation gage. Fig 2 is one

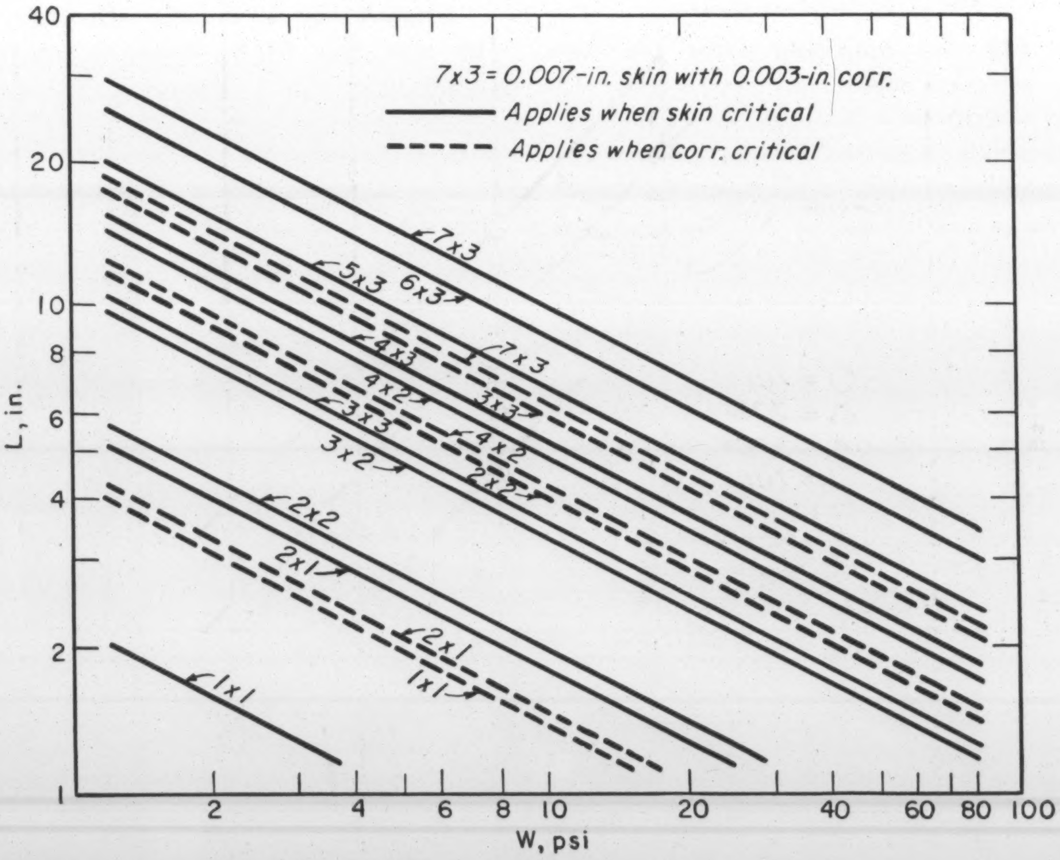


Fig 2—*Allowable pressure loading for No. 1 corrugation.*

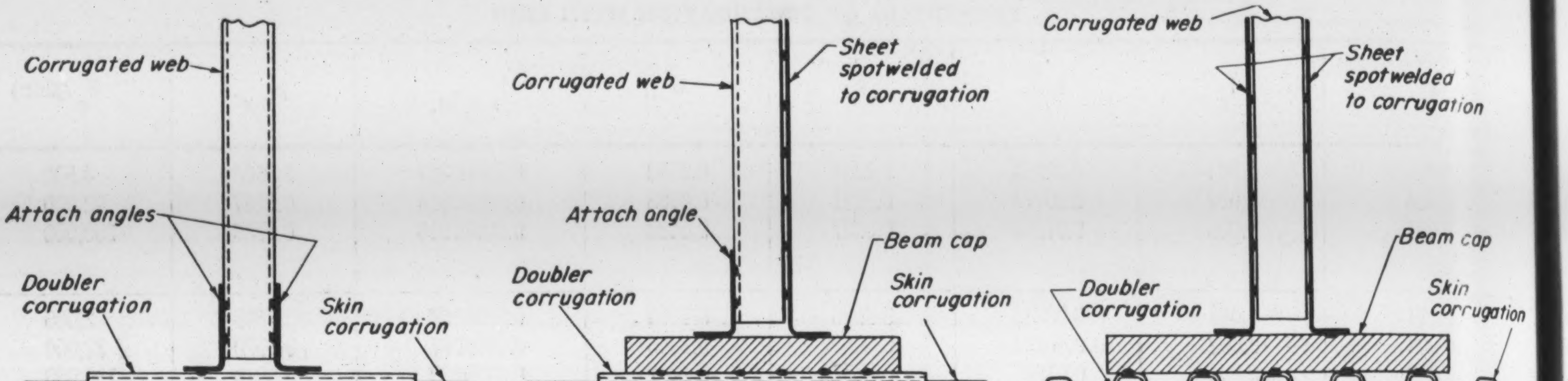

Corrugated web
Attach angles
Doubler corrugation
Skin corrugation
Skin
Corrugated web
Sheet spotwelded to corrugation
Attach angle
Beam cap
Doubler corrugation
Skin corrugation
Skin
Corrugated web
Sheet spotwelded to corrugation
Beam cap
Doubler corrugation
Skin corrugation
Skin

Fig 3—*Three typical spar designs.*

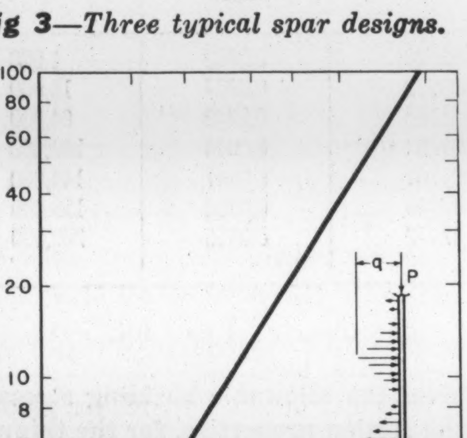


Fig 4—*Stabilizing force for compression cap.*

such graph for No. 1 corrugation.

For example, assume a pressure loading of 10 psi on No. 1 skin-corrugation combination. For a skin gage of 0.005 in. and a corrugation gage of 0.003 in., the required spar spacing is 6 in. As Fig 2 indicates, this pressure loading could also be withstood by a combination of 0.004-in. skin, 0.002-in. corrugation and 4-in. spar spacing. Since the total weight of the structure must include the spar and rib weights, many trials are necessary to arrive at the most efficient combination.

Supporting structure—In order to use the high strength steel efficiently the stiffened foil construction must be carried into all of the supporting structure.

For example, note the typical spars shown in Fig 3. Assume first the usual case where at the spar tip the shear load is practically nil and the spar bending moment is zero. The shear web starts as a 0.001-in. thick corrugation and is attached to the spar cap by two attached angles for stability (3a). Following the spar inboard we find the shear load increasing and forcing an increase in the corrugation gage, the addition of a sheet (3b), or both. A further increase in shear may require the addition of a second sheet (3c), and extremely high shear loads may require use of

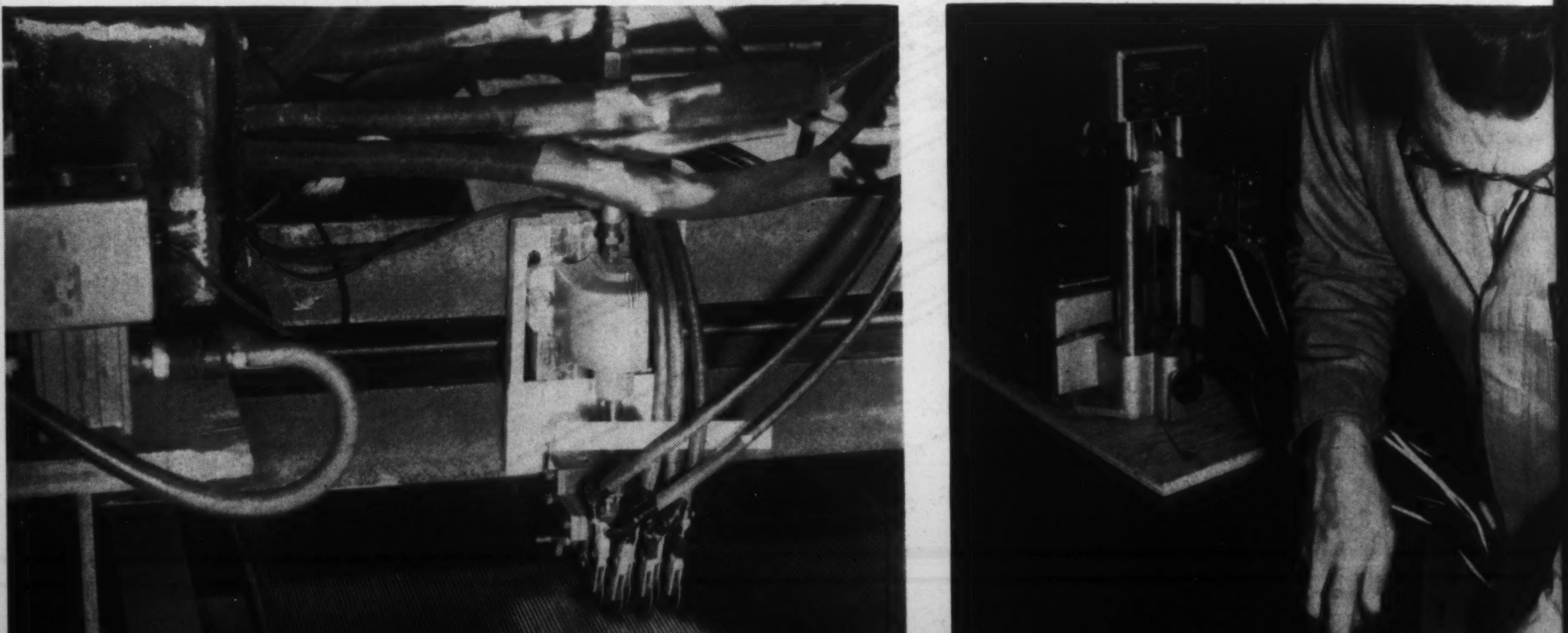


Fig 5—*Corrugations are welded to skins by a multi-wheel spot welding machine (left) or, for inaccessible areas or touch-up, by a hand poke-type spot welder (right).*

individual stiffeners instead of the corrugation.

Similarly, the spar cap may be simply the skin and skin corrugation plus a double corrugation (3a). As the spar moment builds up, the axial load increases until a beam cap is required (3b); this beam cap can start at about 0.004 in. thick and ½ in. wide and increase in thickness and width as the load requires. Such a cap is well stabilized and can work at a stress of 200,000 psi. If the axial stress should increase to 200,000 lb, there would be a full inch of material in the spar cap.

In other cases it may be necessary to consider:

1. The combination of a relatively low shear load and a high spar bending moment. In such cases it is necessary to account for the compressive load put into the shear web by the beam deflection.

2. The directional change of the cap load if the cap is curved geometrically. Additional stiffening in the shear web may be required.

3. The stabilizing force required when the spar cap is considered to be made up of a series of short columns whose length is determined by the radius of gyration of the cap and the column stress in the cap. The stabilizing force alternates in direction from one node of the column to the next, and is considered as a pressure because it is a uniform force across the full width of the cap. As the empirical curve of Fig 4 indicates, at a cap stress of 195,000 psi the stabilizing pressure is 100 psi. Thus, this factor is critical only for the attachment and buckling of very thin webs; in such cases, a narrow cap width is recommended in order to reduce the stabilizing pressure.

The Winner

Responsibility for the development of this new design concept—the use of steel foil for airframes—belongs to Bruce Mitchell, Ryan's chief of structures.

Mr. Mitchell, 52, started his aircraft career at the Sweeney School of Aviation in Kansas City, Mo., in 1927. He graduated as an aeronautical engineer from Tri-State College (Ind.) in 1938. Since then all of his work has been in aircraft, with emphasis on stress analysis and structure design. Prior to joining Ryan, he worked for Lockheed-Vega, Douglas, Convair and Northrop.

Mr. Mitchell joined Ryan in 1953. He was responsible for stress design on the Vertijet, the Vertiplane and the Firebee (high speed target drone missile).

In deep beams with low shear loads it is more economical to use a built-up truss rather than full depth webs. This follows the basic design principle of gathering and concentrating the light loads sufficiently to use the full strength of the material. Ryan has not settled on the best structure for these trusses, but is considering use of tubes with miniature corrugations running lengthwise.

Fabrication

Although sheet gages range from 0.001 to 1.0 in., assembly of structure has not presented serious difficulties. Assemblies are built up from smaller sub-assemblies, the only limitation on size being accessibility for welding.

Both machine and hand welding are used. Production spot welding of the corrugation to the skin can be done with multiple welding units, a roller running in each corrugation (see Fig 5). A certain amount of hand welding is required for final assembly, but this work can be simplified by careful design. A variety of tips can be made for a poke-type welder for use in touch-up work or for welding in hard-to-reach places.

Good welds are made consistently as long as clean, matched surfaces and correct machine settings are used. Micrographs of three typical welds are shown in Fig 6. Ryan solved the problem of welding thin sheet to heavy bar with one limitation: Though the thicker material can be an inch or more thick, the thinner material must be less than 0.016 in. thick.

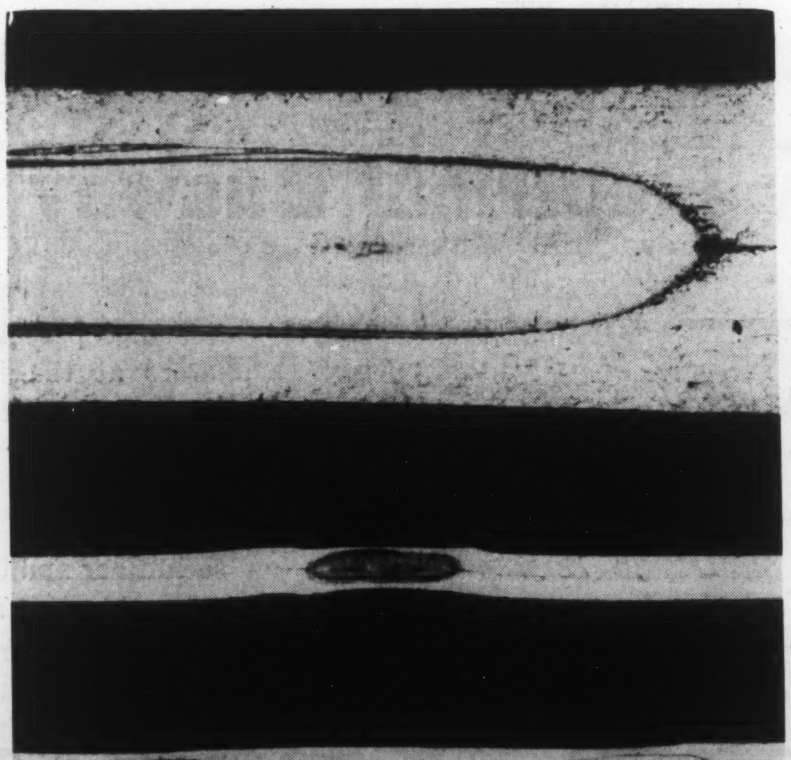
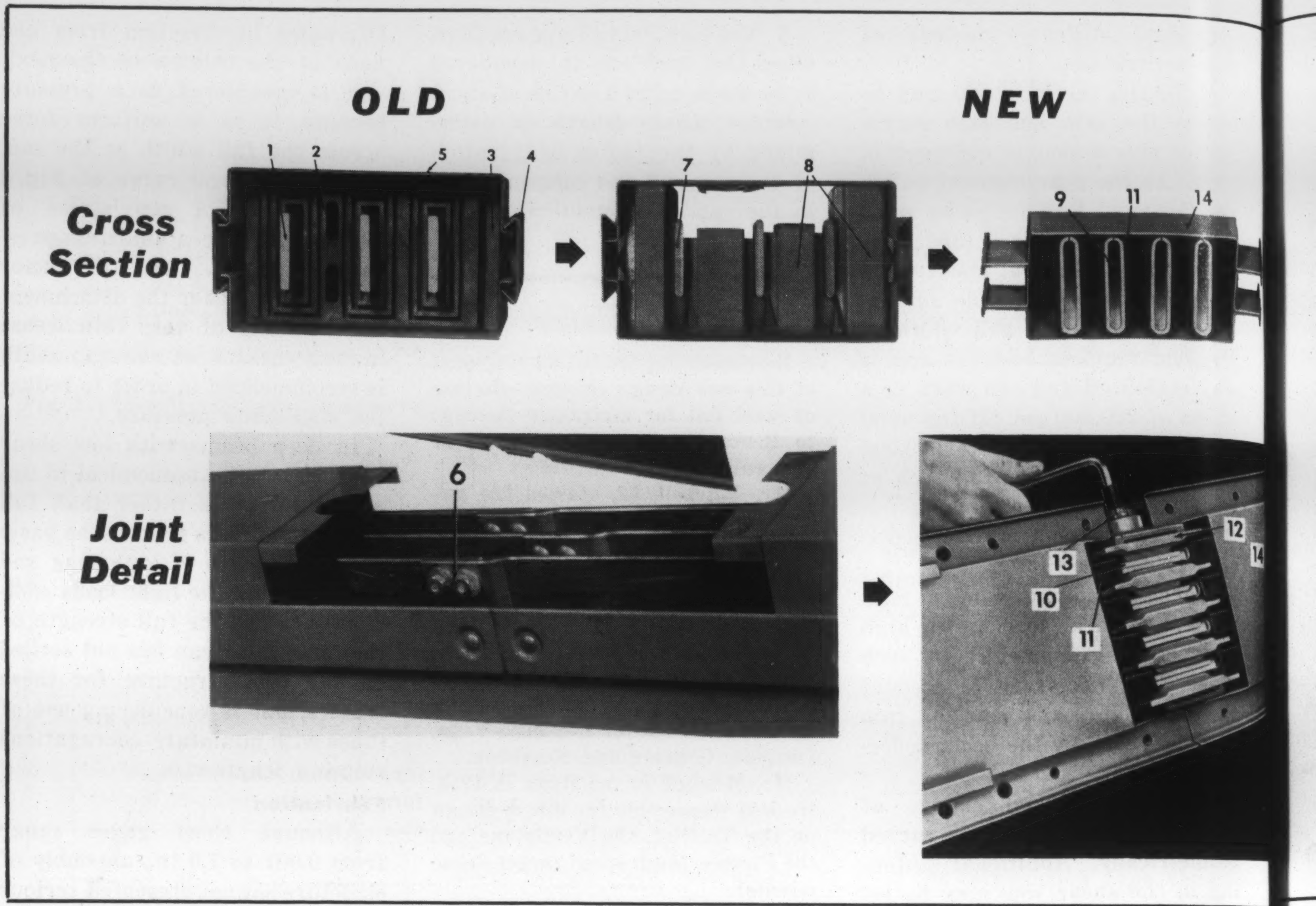


Fig 6—*Micrographs of three typical spot welds.*



Aluminum, Butyl, Alkyd Combined in Radically New Electrical Busway

Award of Merit

FRANK C. JOHNSTON, Product Engineer,
and
*PAUL K. KRAUSS, Design Engineer**
Distribution Assembly Dept., General Electric Co.

■ An important new electrical busway system—smaller, lighter and more efficient than old designs—has been developed through the use of three modern materials: aluminum, butyl rubber and glass-reinforced alkyd plastic. It is the first low voltage (600 v and below) busway system designed specifically for aluminum conductors.

Two redesigns

Until recently most busway systems have made use of these three basic materials: steel for the housing, porcelain for the insulators at the joints, and copper for the electrical conductors. In this particular case the design that was to be replaced had conductors spaced far enough from each other and the housing so that air could serve as insulation.

In 1951 two modifications of the conventional busway were produced using aluminum conductors. However, the basic design was practically unchanged and the full potential of aluminum was not realized. The major disadvantages of the old design still existed; namely, high installation cost, un-

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* Now with GE's Aircraft Products Dept.

TABLE 1—A COMPARISON OF SEVEN FEATURES

	Old esign	New Design	New Material
Relative Installation Cost, %	100	70	Aluminum (30% lighter weight); glass-reinforced alkyd (single bolt joint); butyl rubber (30% smaller size)
Voltage Drop, (L-L/100 ft distr. load), v	3	2¼	Aluminum
Travelling Arcs Avoided?	Yes	No	Butyl rubber
Does Design Offer...			
Safety Plug-in Outlets?	No	Yes	Butyl rubber
Silent Operation?	No	Yes	Butyl rubber
Joint Safety?	No	Yes	Glass-reinforced alkyd
Possibility of Dropping Out a Length Without Disturbing Adjacent Unit?	No	Yes	Glass-reinforced alkyd

Busway Design: Old vs New

In the *old design* the conductors (1) were copper bars. They were supported at regular intervals by porcelain insulators (2). The insulators were held in place by steel channels (3) which were fastened to side rails (4) by a screw. The conductors were held in position by nylon pins (not visible). The housing (5) and the side rails were painted 16-gage steel. Two sets of bolts, nuts and washers (6) were needed to join each of the conductors together.

The *modification* of the original design retained the same housing, but aluminum bars were used for conductors (7) and the single porcelain insulators were replaced by separate porcelain insulators (8). The insulators, held together by steel strapping, were spaced at one-half the interval previously used.

In the *new design* the conductors are aluminum strip roll formed into a rectangular hollow shape (9). Aluminum slugs (10) are welded into the ends of the conductors. The conductor assemblies are silver plated and butyl rubber is applied (except on the slugs) by crosshead extrusion (11). Glass-reinforced alkyd insulators (12) are attached to the end slugs by two screws. To join lengths or fittings, the end slugs are slipped together and the electrical connection is made by tightening only one bolt (13). The conductors, separated at regular intervals by pressed wood blocks, are held together with steel strapping. The housing (14) is roll formed, triple channel, 18-gage steel.

covered conductors which permitted traveling arcs, breakage of porcelain insulators, high voltage drop, heavy weight, and safety hazards at plug-in outlets and joints.

To overcome these and other disadvantages, a complete redesign of the busway was undertaken. The materials used in the new design are EC aluminum (electrical conductor grade) for the conductors and joint slugs, specially formulated butyl rubber for the conductor insulation, and glass-reinforced alkyd for the insulators at the joints. Steel was retained for the housing. Table 1 summarizes the results of the redesign and lists the materials responsible for the advantages gained.

Why aluminum?

Lower cost—The conductors are by far the most costly item in a busway. Therefore, it is important that the lowest cost conductor be used. The following table, based on ¼ x 2 in. material, shows that aluminum is considerably less costly than copper for this application.

	Cu	EC Al
Finished price, $/lb	0.47	0.62
Density, % of Cu	100	30
Conductivity, % of Cu	100	61
Cost per unit of conductivity, % of Cu	100	64

Lighter weight—To carry an equal number of amperes, an aluminum conductor need weigh only 38% as much as a copper conductor. Thus, approximately a 30% reduction in total weight of the busway was realized, as can be seen from the following list, comparing the weights of aluminum and copper conductors.

	Wt of 10-ft Length, lb of		Al
Amp Rating	Al	Cu	% Lighter
400	64	90	29
600	86	120	28
800	104	152	30
1000	121	166	27

Why butyl?

One of the outstanding features of the new design is that the heat generated by the conductors is transferred not only by radiation and convection but also by conduction through the insulation to the steel housing and from the housing to the surroundings by radiation and convection. This permits a substantial reduction in conductor cross-sectional area as compared to the previous design.

Because the insulation must be in intimate thermal contact with the housing and conductors, it must have pliability, high thermal conductivity, no cold flow, and good resistance to mechanical damage in thin sections. It must, in addition, have electrical and heat aging characteristics that will insure satisfactory performance for many years.

A comprehensive study was made of all insulating materials. As a result of this study five materials were selected as worthy of further investigation: polyvinyl chloride, silicone rubber, glass-reinforced polyvinyl chloride, glass-reinforced polyester, and butyl rubber. Preliminary investigation eliminated silicone rubber as prohibitive in price. Glass-reinforced polyvinyl chloride was eliminated because of inability to obtain vendor and apparent high cost. A thorough investigation was conducted on the three remaining materials and butyl was the material finally selected. Table 2 compares a few of the important characteristics of butyl and other insulation materials.

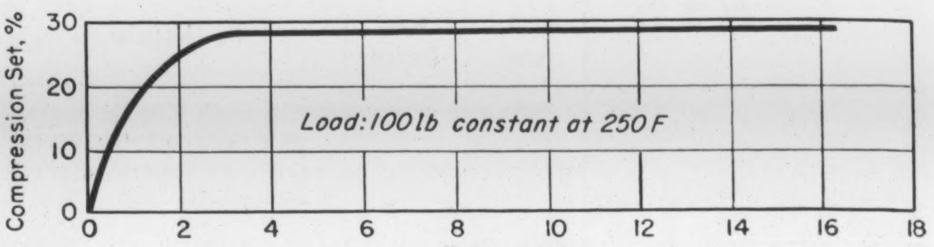
Lower cost—Table 2 reveals that butyl is considerably less expensive than the other materials listed. It can be processed on the same equipment used for other rubbers. It lends itself to extrusion and continuous vulcanization; crosshead extrusion was chosen because of its speed and low die cost.

Good resistance to aging and heat—Butyl is particularly outstanding in its resistance to oxidation and heat. The graphs on p 136 show the effect on tensile strength and elongation of butyl insulation operating at a temperature of 250 F for five years. Note that tensile strength and elongation decrease relatively fast for about 40 weeks until an equilibrium is reached, after which there is little change in these properties. Other rubbers continue to depreciate at a progressive rate depending on time and temperature.

Excellent dielectric strength—Butyl has excellent dielectric strength. Minimum values of 500 v per mil initially and after extreme accelerated aging are obtained with the particular formulation used in this busway. All of the tests on butyl show that its dielectric strength is not affected by time, temperature or condition of aging.

Good arc resistance—A frequent source of trouble in conventional plug-in busways, as typified by the previous design, are traveling arcs. This new design with fully insulated conductors prevents the arcs from traveling. The arc resistance of the material is such that, if an arc is established between conductors, the insulation will not be damaged. In an actual

Butyl rubber's resistance to aging



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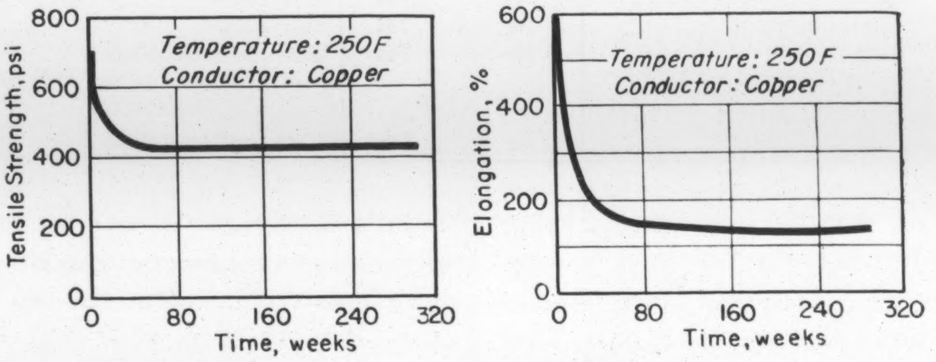


Tensile strength **Elongation**

TABLE 2—PROPERTIES OF INSULATION MATERIALS[a]

Property	Minimum Requirements	Butyl	Polyvinyl Chloride	Glass-Polyester
Dielectric Strength, v/mil	350	**500**	350	300
Min Continuous Operating Temp for Indefinite Life F	230	**230**	194	266
Arc Resistance (ASTM short time), sec	130	**130**	130	130
Cold Flow (25 psi), %	10	**0**	100	0
Ther Cond, Btu/hr/sq ft/°F/ft	0.080	**0.148**	0.085	0.182
Flammability	Self extinguish.[b]	**Self extinguish.[b]**	Self extinguish.	Self extinguish.
Specific Gravity		**1.3**	1.3	1.9
Cost Per Unit Volume Finished M'tl (butyl=100)	Low as possible.	**100**	170	190

[a] All materials listed have many formulations which show a wide variance in properties and cost. The figures given here are for materials specifically formulated to give best results for the characteristics listed.

[b] In this application.

TABLE 3—REQUIREMENTS AND PROPERTIES OF GLASS-REINFORCED ALKYD

Properties	Requirements	Glass-Reinforced Alkyd
Arc Resistance (min, ASTM short time), sec	130	100
Izod Impact Strength (min), ft-lb/in	3.0	3.0
Dielectric Strength (min), v/mil	250	350
Compressive Strength (min), psi	20,000	23,000
Water Absorption in 48 Hr (max), %	0.5	0.3
Heat Compressive Distortion (max), %[a]	0.5	0.3

[a] When molded to shape and compressed in same manner as done in service with total applied force of 5000 lb.

test the busway was connected to a circuit with 50,000 amp rms (t) available. The overcurrent protection was a standard air circuit breaker. A deliberate short was made between conductors and the power turned on. Although the conductors were partially burned away, the butyl insulation was undamaged and the busway still operable.

Low cold flow and compressive set—The new design is such that to maintain intimate thermal contact between the conductor, the butyl and the housing, there must always be pressure exerted on the insulation by the housing and conductor. Thus, little if any cold flow can be tolerated in the insulation used. Butyl exhibits no cold flow. When compressed by a sufficient force, it takes a compressive set. Extended tests run at high temperatures show that the compressive set is initially high but soon levels off (see graph, p 136).

Outstanding fatigue strength—Butyl has outstanding resistance to fatigue. In tests, butyls have taken 3000% more cycles than natural rubber without breaking down. This property of butyl permits safety plug-in openings, an important feature of the redesign. The butyl is cut smaller than the opening in the conductor, providing essentially a "dead front." Because of the good fatigue strength, hardness and elasticity of the butyl, a plug with pointed stabs may be inserted easily and as many times as desired without damage to the insulation.

Why glass-reinforced alkyd?

The new joint design used in fastening together sections of the busway required an insulating material at the joints that would meet rigid physical and electrical requirements. A glass-reinforced alkyd resin was compounded with proper fillers and catalysts to meet the requirements. Table 3 lists both the requirements and the properties actually obtained with the glass-reinforced alkyd material.

Although several other materials were considered for the joint insulation, none of them had all the desired properties. Phenolic has almost zero arc resistance and will track. Glass-reinforced melamine has too low an impact strength and is considerably higher in cost.

Glass-reinforced alkyd can be molded in conventional, positive-type compression molds. It may be purchased in the form of rope which can be automatically cut off for loading in the mold. The material also has relatively long shelf life.

Porous Bronze Tank Vent Is Safer, Costs Less

Award of Merit

RICHARD M. KLAUS, Project Engineer

OPW Corp.

■ Use of porous bronze has made it possible to develop a simpler and safer vent for gasoline storage tanks.

Why a redesign?

Redesign of such vents was made necessary by revision of the National Board of Fire Underwriters' code for storage of flammable liquids to read: "Vent pipes shall discharge vapors only upward or horizontally (not downward) in order to disperse vapors."

Before the revision, tank vents were usually quite simple. As shown above, they consisted of a metal cover to prevent entry of rain and a screen to exclude other foreign objects. This type of vent discharged vapors downward. Since gasoline vapor is heavier than air, it tended to collect in pockets on the ground and became a hazard.

Requirements

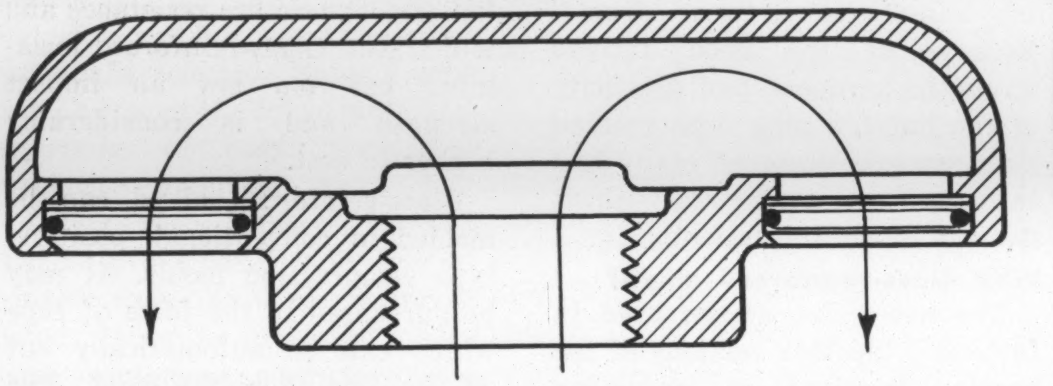
The requirements of a vent that will meet the new code are quite extensive. The part must:

1. Prevent rain or other contaminants from entering the tank.
2. Allow vapor to pass outward with minimum restriction to flow.
3. Be resistant to attack by the atmosphere and gasoline vapors.
4. Have a long service life.
5. Be easy to install and require no maintenance.
6. Be inexpensive.

Materials investigated

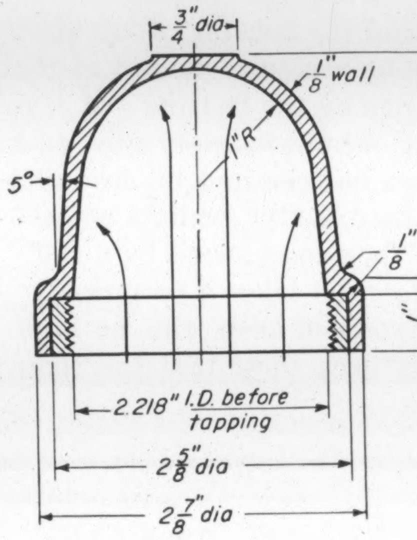
In the initial stages of development, elbow or tee designs, pipes set at an angle of 45 deg, and funnel designs were investigated. All were discarded because they failed to completely exclude water

OLD



No. 13 (2") Porous Metal Vent
PAT. PEND.

NEW



and dirt. Attention was then turned to new materials or forms. Perforated metal was discarded because even the smallest holes permitted the entry of water. A double layer of expanded metal was an improvement but not entirely satisfactory. Porous ceramic material excluded entry of water and dirt but offered too great resistance to the flow of vapor. Chemically treated woven wire cloth fulfilled most of the requirements but had unsatisfactory service life.

Finally, metal powder parts were evaluated. Tests showed that drops of water 0.020 in. in dia could not pass through a compact having 40 to 50% voids, and that this degree of porosity also prevented passage of dirt particles larger than 0.005 in. in dia. At the same time, restriction to flow of the vapor was low. The metal powder part also acted as a flame arrestor; if escaping vapor was ignited, the metal prevented the flame from striking back into the tank. Satisfactory corrosion resistance was obtained by making the part from 90 copper-10% tin bronze.

Design of part

Although many 1¼-in. vents are used, modern service stations prefer 2-in. vents to allow low pressure venting of the air displaced by inflow of gasoline. Since most deliveries are made by gravity, the speed at which a delivery can be made is a direct function of the size and restriction of the vent line; at 100 gpm, pressure for a 1¼-in. vent line is 4 in. H_2O; for a 2-in. vent line it is only 0.8 in. H_2O. A 2 in. diameter vent was decided upon.

Based on charts issued by the manufacturers of porous bronze parts, it was determined that a surface area of 11 sq in. would result in a vent line pressure of 1.0 in. H_2O. This area was selected because it was considerably lower than the vent line pressure in the 1¼-in. lines.

The final factor was shape. Consideration was given to a cone, a cylinder, a hemisphere and a paraboloid. To maintain the 2-in. base diameter with an 11 sq in. area, it was necessary to eliminate the hemisphere. The cone was eliminated to reduce height. Possibility of build-up of dirt on the horizontal surface with resulting restriction to flow caused the cylinder to be discarded.

Thus, the final design was based on a paraboloid. Production considerations required the inclusion of a small horizontal flat surface at the top. A reinforcing ring produced from iron powder was added to the bottom. The completed design is shown on p 138.

Performance and cost

Tests of the part showed:

1. Rain does not penetrate the bronze dome even in a heavy shower.

2. Vapor passes through the dome with a pressure drop less than 30% of that through a 1¼-in. open vent line pipe.

3. No corrosion after two years in heavy industrial service, and no deterioration from gasoline vapor.

4. No accumulation of foreign material on vent.

5. Installation is simple, requiring merely screwing on the end of the pipe.

6. No maintenance is required; flow of vapor through the vent cleans dust from the outside of the dome.

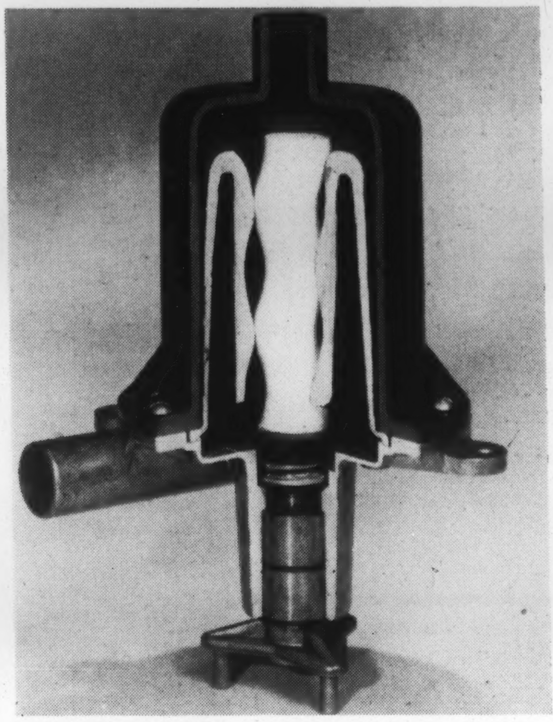
7. It is low in cost. Selling price is $3.15.

Die Cast Zinc Rotor Lengthens Life of Washer-Drier Pump

Award of Merit

ST. JOSEPH DIVISION, WHIRLPOOL CORP.

Combination Engineering and Combination Cost Reduction Committee



Cut-away view *of pump shows chromium plated rotor, rubber stator.*

■ Field service tests on combination washer-driers showed that pump failure occurred in the rotor and/or stator. Analysis of the failures indicated that a pump life of only 80 hr could be expected if a hard rubber stator and a molded phenolic rotor were used under conditions in which sand or other abrasive entered the machine. Laboratory tests aimed at improving the design showed that a chromium plated, die cast zinc rotor offered the best performance at lowest cost. Such a rotor is now standard equipment in production models of the washer-drier.

How tests were made

In order to have a basis for developing an improved design, it was necessary to translate the service tests into laboratory tests that could be run under controlled conditions. Thus, it was necessary to: 1) establish the flow rate loss that would seriously impair the efficiency of the machine, and 2) set the operating conditions that would give results comparable to the field tests.

1. *Flow rate loss*—Observation of the flow pattern from a recirculating nozzle on a machine showed that the flow rate on new pumps (8 to 9 gpm) gave stream coverage from the front to the back of the cylinder. Reducing the flow to 7½ gpm gave the same coverage but the stream impinged on the cylinder at a lower point. At 6½ gpm, coverage of the cylinder was reduced to 75%; at 5½ gpm, coverage was reduced to 50%. Based on these figures, a reduction in flow of 2 gpm was selected as the criterion for pump wear for test purposes.

2. *Operating conditions* — Experimental work designed to reproduce the wear encountered under service conditions showed that sand, fine grit, lint, tap or well water can cause wear of a molded phenolic rotor. The same work showed that the use of a soft rubber stator (50 durometer hardness) instead of a hard rubber stator (70 durometer) resulted in longer service life of the rotor.

A test procedure was established in which 3 gm beach sand and 3 gm of porcelain grit in 4 gal tap water were recirculated at 170 F.

Evaluation of a rotor-stator combination of the type that had failed in service showed that the rate of wear was similar under field and laboratory conditions.

Materials investigated

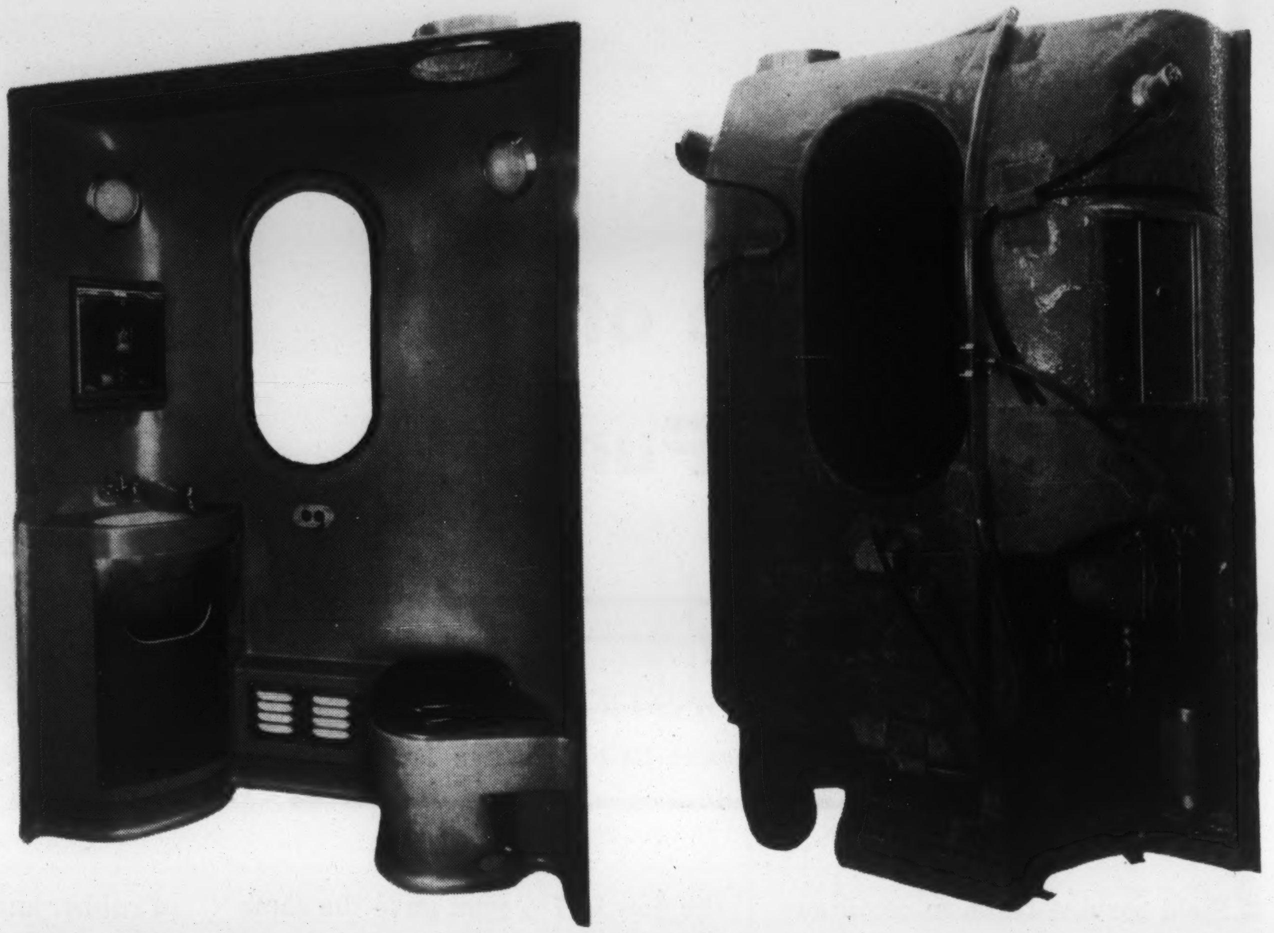
Many materials were considered for the rotor. They included acrylics, low pressure polyethylene, polystyrenes, nylon, a combination of rubber and thermosetting resin, glass-reinforced polystyrene, die cast zinc, rubber coated steel, ceramic coated steel and plated steel.

Among materials finally selected for testing were phenolics, nylon, stainless steel coated with 0.003-in. chromium plate, and both die cast and machined zinc coated with 0.003-in. chromium plate. Each was tested in combination with stators ranging in hardness from 50 to 70 durometer.

The tests showed that die cast, chromium plated zinc rotors with 50 durometer rubber stators had the longest life expectance of all material combinations tested. Machined zinc and stainless steel rotors were discarded because of higher cost than die cast parts. Molded phenolic rotors had very short life expectancy, even under tests using no abrasives.

Both die cast zinc and stainless steel rotors that had been chromium plated were satisfactory from the viewpoint of quality. However, there was a great difference in cost:

	Cost Per Piece
Zinc die casting with 0.003-in. chromium plate	$0.52
Stainless steel with 0.003-in. chromium plate	$1.45



Plastics lavatory—*Glass-reinforced molding is used for entire lavatory structure. Back view (right) shows corrosion resistant vinyl piping which withstands freezing and is used for all except hot water lines.*

Plastics, Better Use of Stainless Produce Lightweight Railway Car

Award of Merit

W. B. DEAN, Chief Engineer

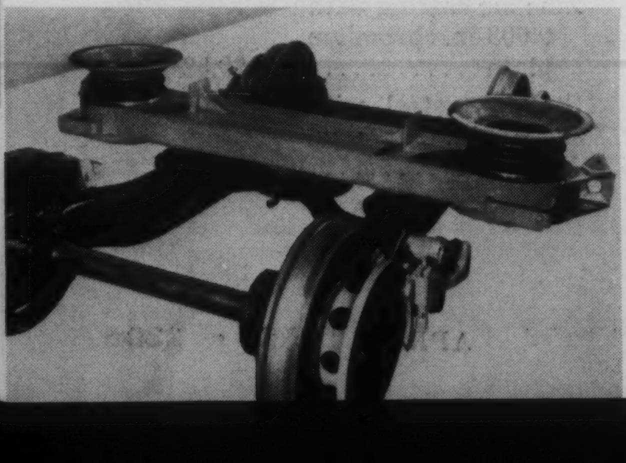
and PRODUCT RESEARCH DIVISION

Budd Co.

■ The objective of Budd's railway car redesign was to produce a structurally sound, extra light passenger car with low initial cost, low maintenance and operating costs, and improved riding comfort. At the outset it was decided that the car should weigh less than 600 lb per passenger, as compared to over 1800 lb per passenger for a conventional lightweight car.

Weight savings were achieved in three ways: by the better use of existing materials; by the use of strong, lightweight plastics; and by creating new design concepts (see wheel truck photo).

Truck—*Weight saving of 65% is realized in truck by using revolutionary design and air springs. Other advantages: a more comfortable ride and a minimum of maintenance.*



Stainless structure

In the first category, a weight savings of 58% was achieved by better distributing the stainless steel in the car body structure to give more uniform stress loading. Weight was also saved by eliminating non-structural decorative metals and utilizing wherever possible the aesthetic properties of structural stainless steel to give a pleasing appearance.

Wide use of plastics

In the second category, wide use was made of intricate fiberglass-reinforced polyester plastics forms which could be produced at relatively low cost in small quantities. Examples include:

1. Entire interior lining.
2. A sanitary interior washroom (see photos) which is easily

cleaned and so constructed as to eliminate bacteria-harboring cracks and corners.

3. Molded two-place seats that are approximately 100 lb lighter than conventional seats.
4. Interior doors of sandwich construction that are insulated and stiffened with urethane foam.
5. Air ducts of complex form.
6. Translucent corrugated light shades.
7. Non-corrosive battery cases.
8. One-piece stairwells.

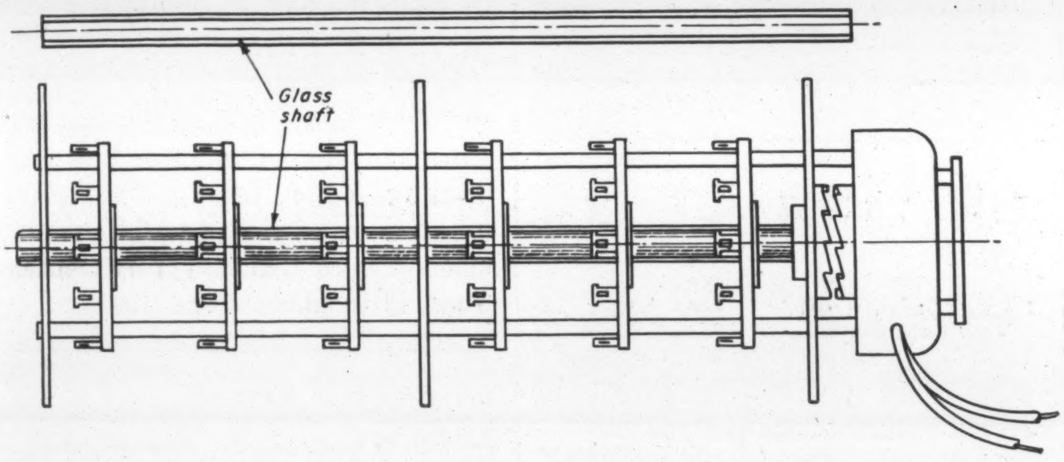
Many of the above parts are permanently colored and do not require any painting or maintenance.

In addition to the above, vinyl plastic is used extensively for decorative purposes and for items requiring high wear resistance. Typical uses are seat covers, floor tile, light reflectors, and decorative covering for the combination light fixture and air duct. Because of its resistance to corrosion and accidental freezing, vinyl piping is also used in the washroom and for other interior water lines.

An important maintenance item is eliminated by using self-lubricating polytetrafluoroethylene bearing surfaces on the wheel trucks. The material is also used as a working seal in the leveling valve. Filled plastics are also used in the bushings of the disk brakes to reduce maintenance.

Additional details and pictures can be found in a previous report on this redesign which appeared in the Jan '57 issue of MATERIALS & METHODS, p 119.

Tempered Glass Shaft Supports Wafer Switches



Cross section *of stepping switch using ground and tempered glass rod as shaft.*

■ An unusual application of tempered glass is its use as a shaft to carry a line of rotary wafer switches in a solenoid-operated stepping switch. A nonmetallic shaft is necessary because of certain radio frequency characteristics encountered in the installation. Of available nonmetallic materials, tempered glass was selected over untempered glass, plastics and ceramics because of its rigidity and its good flexural and impact strength.

Melamine, high pressure laminates, phenolic and fiberglass rods failed because they had excessive torsional deflection in operation and because they were too soft to stand up under the vibratory type of drive. Ceramics such as steatite, sintered metallic oxides and synthetic mica were too fragile because of their hardness and rigidity. Tests show that tempered glass has flexural and impact strengths double that of synthetic mica.

How shaft is made

To fabricate the shaft, untempered lime glass is ground to 0.249 in. dia by centerless grinding and flattened on opposite sides to 0.187 in. across flats by surface grinding. Following all cutting and machining operations, the glass rod is tempered; tempered glass is made by heat treating glass to form a surface skin that is in compression while the core area is in tension.

Properties of tempered glass

Tempered glass is three to five times stronger than untempered glass in sustaining loads and resisting fracture due to strain. It is about three to five times more resistant to impact shock from blunt objects, and about four times more resistant to thermal shock, than untempered glass. Its flexibility under stress is the same as that of the original glass, but it may be flexed from four to five times farther than normal glass before it breaks.

In a test to demonstate its shock resistance, a tempered glass disk 1/4 in. thick by 3 in. dia was dropped successively from 4, 6, 8, 10 and 18 ft without damage. A duplicate disk of ordinary plate glass shattered when dropped on a hardwood floor from a height of 3 ft.

Award of Merit

EDWARD LOUTHAN, Project Engineer

Hoffman Laboratories, Inc.

Here are the award winners

First Award

$500 and plaque

RYAN AERONAUTICAL CO.
San Diego, Calif.

Development of a new basic design for aircraft structures through sound and imaginative use of stainless steel foil. *Page 128*

Awards of Merit

$100 and certificate

FRANK C. JOHNSTON,
Product Engineer, and
PAUL K. KRAUSS,
Design Engineer
Distribution Assemblies Dept.
General Electric Co., Plainville, Conn.

Redesign of electrical busway making use of aluminum, butyl rubber and alkyd plastics to reduce bulk, weight and cost. *Page 134*

RICHARD M. KLAUS,
Project Engineer
OPW Corp., Cincinnati, Ohio

Redesign of vent for gasoline storage tank making use of porous bronze compact to increase safety and reduce cost without impairing performance. *Page 137*

WHIRLPOOL CORP.
St. Joseph Div., St. Joseph, Mich.
Combination Engineering
and Combination Cost Reduction
Committee

Selection and use of chromium plated, die cast zinc rotor to lengthen life of combination washer-dryer. *Page 139*

WALTER B. DEAN,
Chief Engineer, and
PRODUCT RESEARCH DIVISION
Budd Co., Philadelphia, Pa.

Efficient use of stainless steel and broad use of reinforced plastics in design of lightweight railway passenger car. *Page 140*

EDWARD LOUTHAN,
Sr. Project Mechanical Engineer
Hoffman Laboratories, Inc.
Los Angeles, Calif.

Imaginative selection and use of tempered glass rod as shaft to support rotary wafer switches. *Page 141*

Citations

$50 and certificate

LESTER R. MOSKOWITZ,
Chief Development Engineer,
and
ROBERT R. PETERSON,
Development Engineer
Eriez Mfg. Co., Erie, Pa.

Use of disk springs made from parallel fiber, glass-reinforced plastics to improve design and performance of a vibratory feeder. *Page 144*

PAUL T. BARNES,
Design Engineer
U. S. Naval Ordnance Test Station
China Lake, Calif.

Use of phenolic-glass plastic molded in place to reduce failures in a rocket exhaust nozzle. *Page 146*

FLUOR PRODUCTS CO.
Whittier, Calif.

Development of more efficient film-type packing for cooling towers making use of injection molded polystyrene and polyethylene. *Page 147*

HARRY J. DOYLE,
Sr. Engineer, Materials & Processes,
and
GEORGE F. MOLBY,
Sr. Engineer, Structural Design
Martin Co., Baltimore, Md.

Use of reinforced plastics prepregs and epoxy molding to reduce weight and cost of electronic housing and support on seaplane. *Page 149*

RONALD DAUGHERTY,
Associate Scientist
Rosemount Aeronautical
Laboratories
Dept. of Aeronautical Engineering
University of Minnesota
Rosemount, Minn.

Careful selection of materials to insure precise, long-time operation of variable diffuser for hypersonic wind tunnel. *Page 150*

ANTHONY DONATO,
Industrial Designer
Lightolier, Inc., Jersey City, N. J.

Design of attractive, flexible, floor-to-ceiling lamp pole based on use of a carefully designed aluminum extrusion. *Page 152*

D. E. PULSIFER,
Supervisor
Defense Projects Research, and
B. L. WATERHOUSE,
Plastics Engineer
Kawneer Co., Niles, Mich.

Development of a fastening and sealing edge for prefabricated plastics sandwich panels making use of high density polyurethane foamed in place. *Page 153*

ROBERT I. PRUPIS,
Consultant
Newton Centre, Mass.

Design of contact carrier in a resistor box trimmer making imaginative use of polytetrafluoroethylene's cold flow properties. *Page 155*

HOBART BROTHERS CO.
Troy, Ohio

Redesign of arc welding helmet using glass-reinforced plastics to simplify fabrication and increase wearer comfort. *Page 156*

BIRDAIR STRUCTURES, INC.
Buffalo, N. Y.

Design of air-supported enclosure for all-weather swimming pool based on use of clear polyester film and a synthetic fabric. *Page 158*

Honorable Mention

RUSSELL W. HENKE, President
Russ Henke Associates
Elm Grove, Wis.

Careful analysis of materials requirements, leading to development of new motor scooter design.

JOHN J. FAGAN, Ammunition Design Engineer, Picatinny Arsenal
Dover, N. J.

Judicious materials selection in redesign of an anti-personnel mine resulting in 50% reduction in number of components and cost.

WILLIAM PRESTON, Project Engineer, ANTHONY IANETTI, Product Designer, and DAVID SILVERMAN, Chief Engineer of Research and Engineering Division
Helipot Corp., Mountainside, N. J.

Careful materials selection in design of a higher temperature, miniaturized potentiometer.

RAYMOND G. HARTENSTEIN
Development Engineering Section
Air Arm Division, Westinghouse Electric Corp., Glen Bernie, Md., and JAMES J. KERLEY, JR., Design Engineer, Kerley Engineering, Inc., Cheverly, Md.

Design of a radically new shock and vibration mounting using stainless steel cable embedded in vinyl.

P. W. LYNAHAN, Sr. Development Engineer, and IRVING SHAPIRO, Sr. Materials Engineer
Vertol Aircraft Corp., Morton, Pa.

Use of a fire retardant paint to protect engine compartment of commercial helicopter.

R. L. BROWN, Manager, Substation & Tap Changer Engineering
Transformer Division, Westinghouse Electric Corp., Sharon, Pa.

Use of glass-reinforced plastics moldings, castings and tape to improve performance and reduce bulk of a current-limiting reactor.

GEORGE N. CHATHAM, Vice President, Chatleff Valve & Mfg. Co., Austin, Tex.

Use of screw machine parts and mass welding to insure high quality and good design flexibility in hermetic refrigeration valves.

JOSEPH E. MONTALBANO,
Sr. Design Engineer, Aircraft Armaments, Inc., Cockeysville, Md.

Use of glass-filled, high impact phenolic molding to reduce cost of tail assembly for bazooka rocket.

STROMBERG-CARLSON CO.
Value Engineering Dept.,
Electronics Div., Rochester, N. Y.

Six component redesigns using careful materials selection to achieve cost savings ranging from 25 to 75%.

The Four Judges

Nielsen

Chairman, Dept. of Metallurgical Engineering, New York University

Many of the non-winning entries showed merely the final selection of the material and the final design without showing the process of arriving at the conclusions.

Bonanno

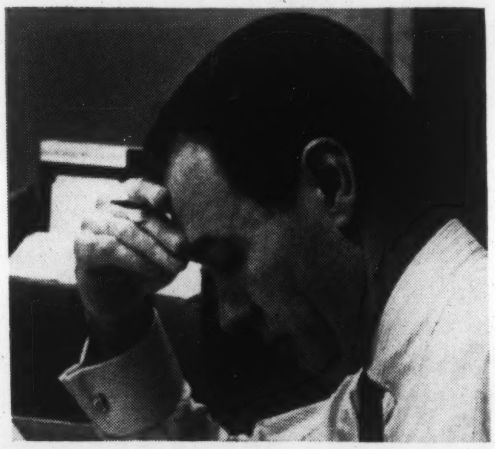
Chief Engineer,
Lionel Corp.

Despite the fact that the entries were generally of a high caliber, the judges had surprisingly little difficulty in agreeing as to the winners.

Sepavich

Manager, Research & Development Dept., Crompton & Knowles Corp.

The entries spoke very well for the ingenuity displayed by various designers in selecting and applying the best material for their particular requirements.

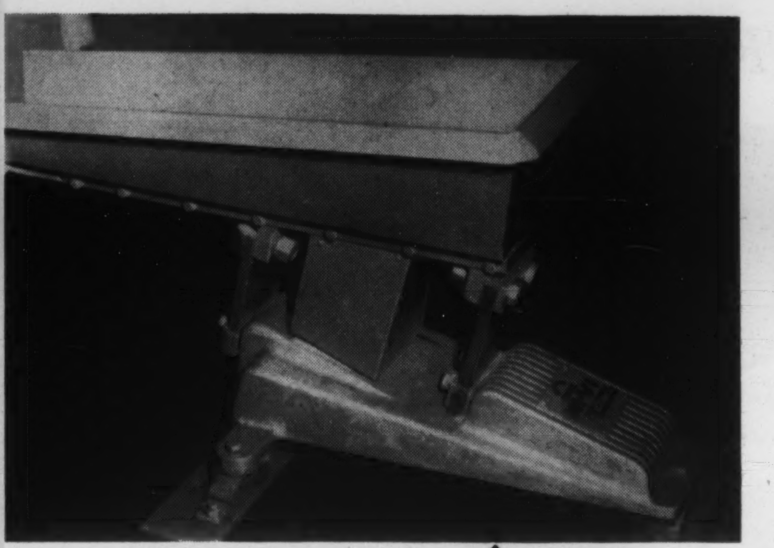


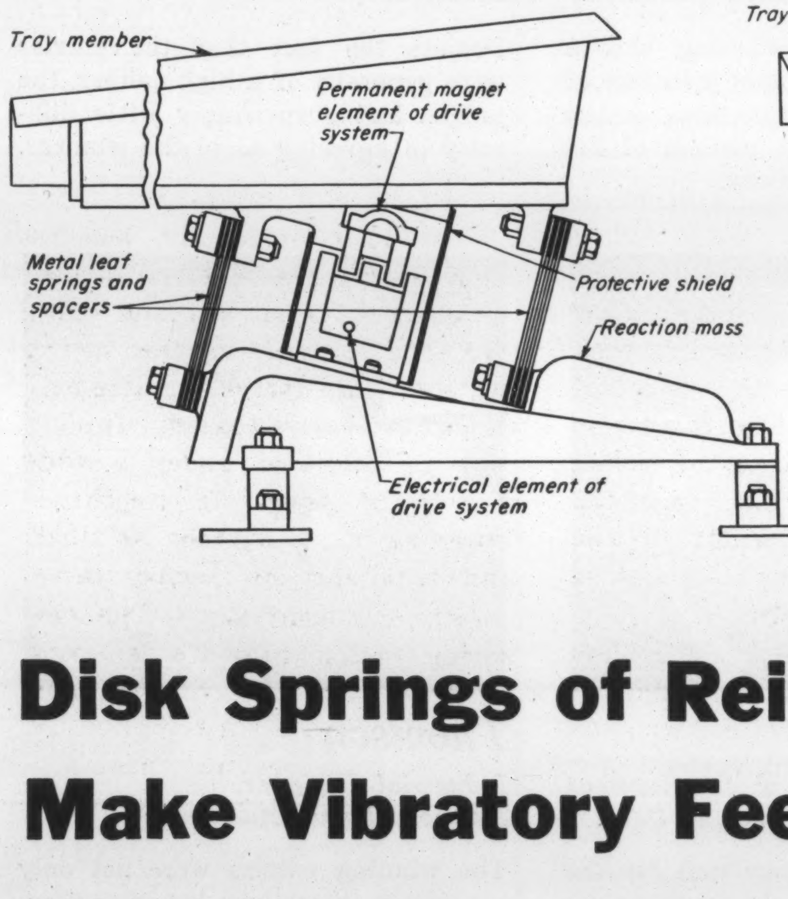
Thomson

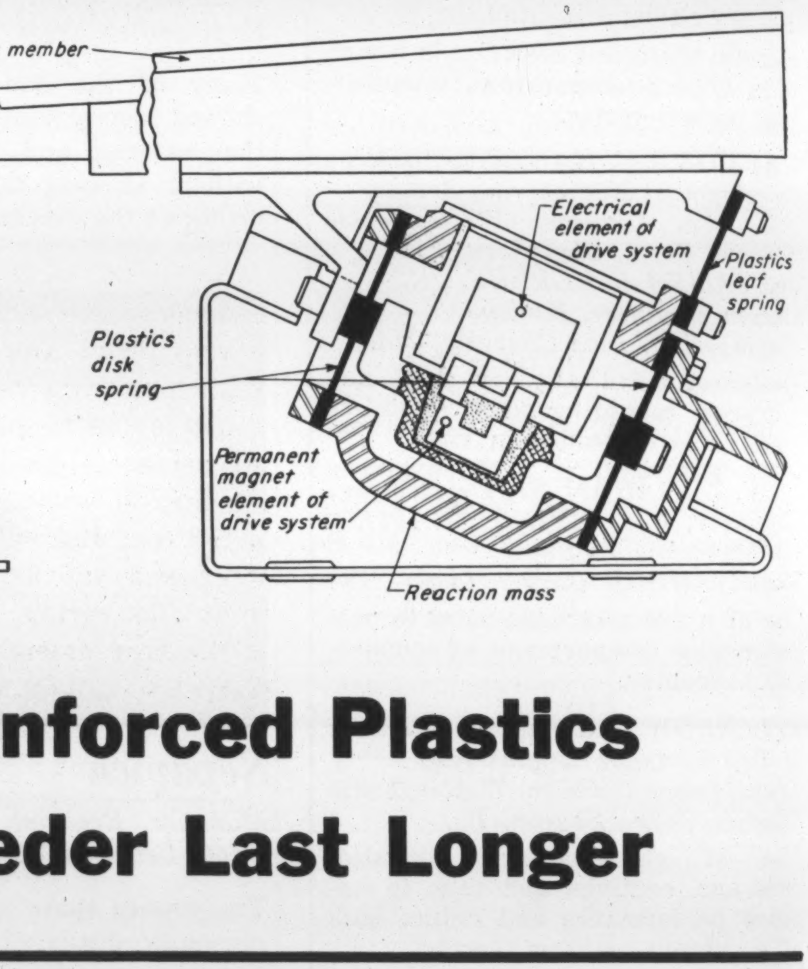
Industrial Designer,
Raymond Loewy Associates

The winning entries were not only exciting in themselves, but were thoroughly prepared and generally well presented with lucid explanations and full documentation.

The four judges: Prof. John P. Nielsen, Joseph L. Bonanno, Victor F. Sepavich and Peter Thomson.







Disk Springs of Reinforced Plastics Make Vibratory Feeder Last Longer

Citation

*L. R. MOSKOWITZ, Chief Development Engineer,**

and R. R. PETERSON, Development Engineer

Eriez Mfg. Co.

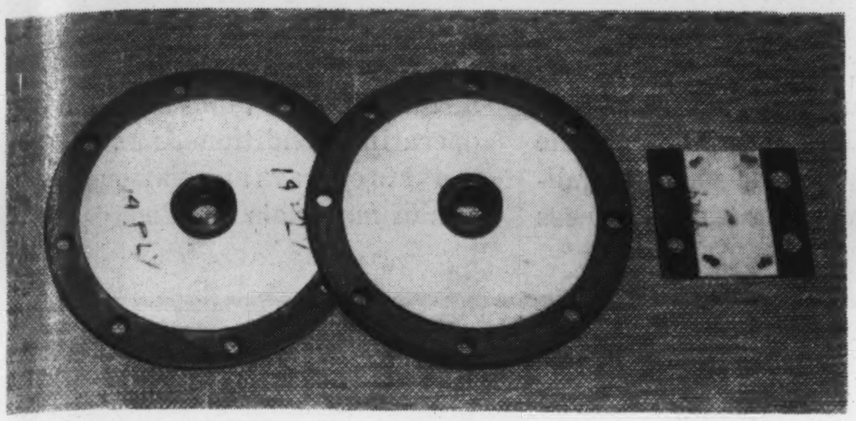
■ Electromagnetic vibratory feeders consist basically of 1) a tray which carries the materials being fed, 2) a reaction mass against which the tray element acts, 3) a spring system which provides both support for the tray and energy transmission between the reaction mass and the tray, and 4) an electromagnetic drive system which provides the energy to the spring.

By eliminating multiple metal leaf springs and redesigning such a feeder around two reinforced plastics disk springs and one reinforced plastics leaf spring, Ereiz Mfg. Co. produced a vibratory feeder having greater efficiency, longer life and greater economy of operation than old designs.

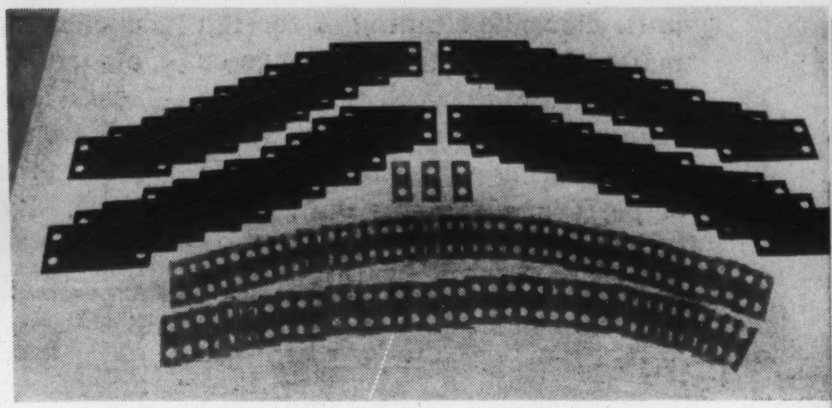
Old design

An accompanying drawing shows the old design. The two leaf spring bundles are composed of a number of SAE 1095 steel springs, each separated from adjacent springs by brass or steel spacers.

*** Since the preparation of his entry, Mr. Moskowitz has resigned from his position at Eriez Mfg. Co. to form L. R. Moskowitz & Associates, an industrial consulting organization. His association with Eriez continues on a consulting basis.**



These three parts in the new design . . .



. . . replace all of these parts in the old.

The number of springs varies with the feeder model, ranging from 13 springs and 28 spacers in the smallest, to 42 springs and 94 spacers in the largest. One end of each spring bundle is bolted to the tray assembly and the other end to the reaction mass. The electrical element of the drive system is attached to the reaction mass; the permanent magnet element is attached to the tray assembly.

Extensive field experience indicated that the leaf spring-type conveyor could not meet the maximum desired service requirements in terms of efficiency of operation, service life, or economy of operation. It also became evident that the ideal requirements could not be met at reasonable costs using conventional spring systems. Thus was devised the disk spring concept in which the spring is clamped both at the circumference and at the center of the disk.

New design

The spring system of the new design (see drawing) consists of two flat disk-shaped springs and one cantilever leaf spring, all made of a controlled filament, glass fiber-reinforced epoxy laminate (Scotchply 1002). The primary structural elements in the laminate springs are the specially oriented continuous parallel glass filaments, of one filament depth and bonded with an epoxy resin. Alternating plies of the laminate are oriented at 90 deg to provide isotropic strength characteristics.

The tray assembly is attached by a machined lug to the center of the front disk spring and bolted to one end of the cantilever leaf spring. The other end of the leaf spring is attached to the reaction mass which consists of a symmetrical steel casting provided on each end with a ring-shaped machined surface to which are attached the outer circumferences of the front and rear disk springs. Attached to an opening in the side of the reaction mass and enclosed by the mass is the electrical element of the drive system.

Also inside the reaction mass is an aluminum casting in which is potted the magnetic element of the drive system. The casting is attached at one end to the center of the rear disk spring, and at the other end to the center of the front disk spring, and through it to the tray assembly.

Materials selection

The major problem in designing the new spring system was to select a material which would provide, in only two disk members, the required spring force, and would withstand the stress levels to which the spring would be subjected at the desired deflection. (The third spring member, the plastics leaf spring, supplies only about 25% of the required spring force.)

The materials investigated were:

1. Metals, including steels, titanium, phosphor bronze and beryllium copper.
2. Homogeneous nonmetallics, including epoxy, phenolic, melamine and nylon plastics, and Mylar film.
3. Nonmetallic laminates, including cotton-phenolic, glass cloth-melamine, glass cloth-epoxy, random glass mat-epoxy, parallel glass filament-polyester, controlled glass filament-epoxy, and high pressure wood.

On the basis of extensive calculations and development testing, controlled glass filament-epoxy laminates were selected as the best material to meet design requirements.

Benefits derived

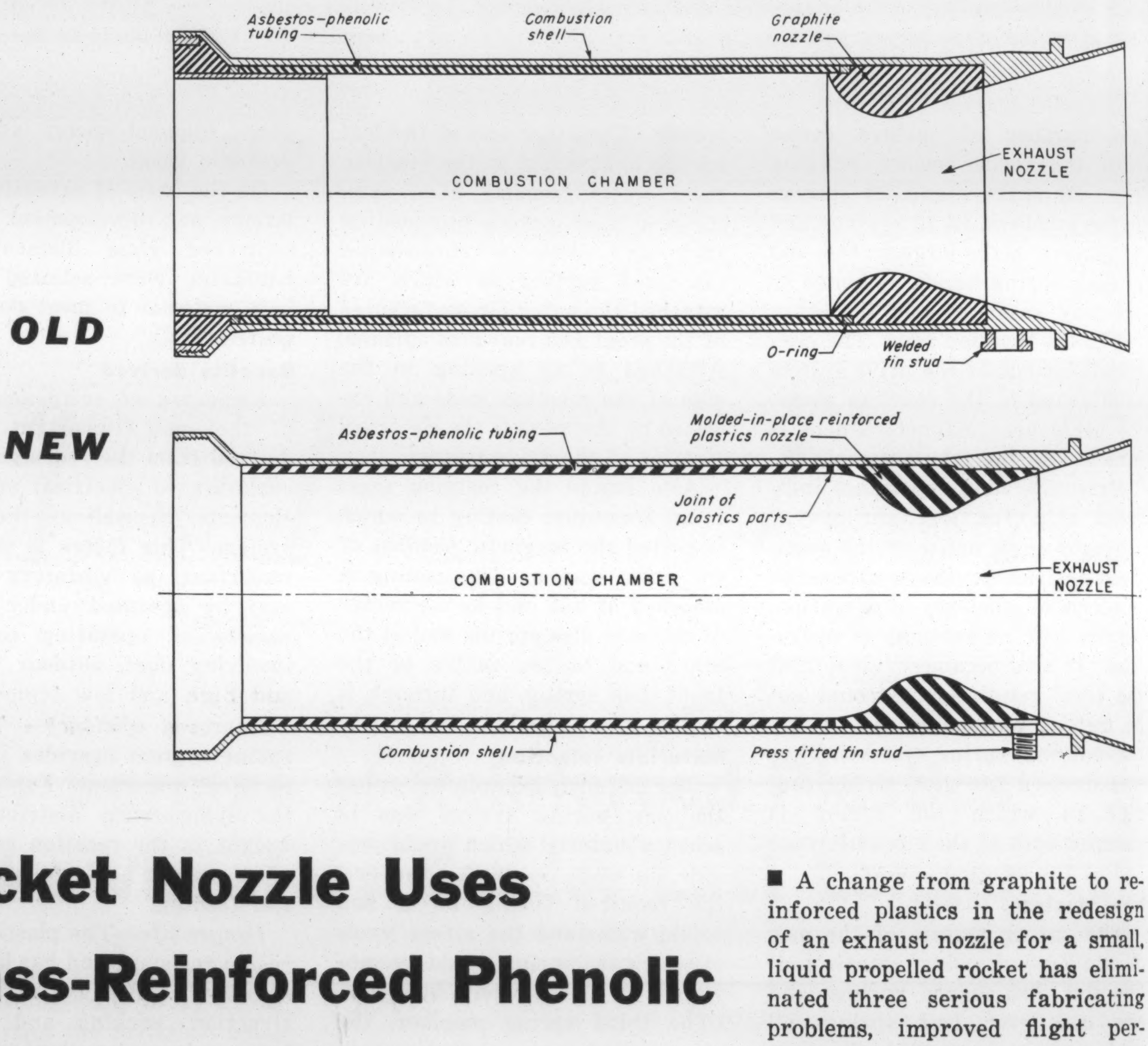
Enclosure of components—One of the most important benefits derived from the redesign is easy enclosure of electrical and drive elements, as well as the spring system. This factor is extremely important, as vibratory feeders may be operated under a wide variety of operating conditions involving dust, outdoor weather, and high and low temperatures.

Improved efficiency — The new spring system provides improved dynamic operation. For example, the symmetrical distribution of weight in the reaction mass provides greater uniformity of material feeding.

Longer life—The plastic is corrosion resistant and has low notch sensitivity. Because of the construction, packing and fretting between leaves are eliminated. The laminated construction eliminates the catastrophic failures that would occur with homogeneous metal spring systems; failures in the laminated material are gradual, progressing at a relatively slow rate.

Economy of operation—The reduction in the number of elements in the spring system from as many as 45 steel springs and 90 brass spacers to two disk springs and one leaf spring provides, in addition to obvious manufacturing economies, a maintenance-free unit. Periodic cleaning of foreign material from between springs or from around drive elements is not required, and no areas exist where such packing will affect the life or performance of the unit.

Design flexibility—The use of one leaf spring member to provide a portion of the spring force presents a simple means to obtain design flexibility in altering the unit to meet various service conditions. By varying the thickness of the single leaf spring or the number of leaf springs used, the basic feeder design can be readily adapted for virtually any desired operating conditions, i.e., various weights of trays and various densities of materials handled.


Asbestos-phenolic tubing
Combustion shell
Graphite nozzle
COMBUSTION CHAMBER
EXHAUST NOZZLE
OLD
O-ring
Welded fin stud
NEW
Asbestos-phenolic tubing
Molded-in-place reinforced plastics nozzle
Joint of plastics parts
COMBUSTION CHAMBER
EXHAUST NOZZLE
Combustion shell
Press fitted fin stud

Rocket Nozzle Uses Glass-Reinforced Phenolic Molded in Place

Citation

PAUL T. BARNES, Design Engineer

U. S. Naval Ordinance Test Station

■ A change from graphite to reinforced plastics in the redesign of an exhaust nozzle for a small, liquid propelled rocket has eliminated three serious fabricating problems, improved flight performance, and effected a cost savings of 30% over the old design The rocket, called Lar, is said to be the smallest liquid propelled rocket to go into experimental production (5-in. dia).

The temperature of the flame coming from the exhaust is about 5000 F, and pressure inside the rocket's combustion chamber is about 1500 psi. Even though burning time is exceptionally short, a heat resistant exhaust nozzle is necessary to protect the combustion shell. At the same time, a high strength steel chamber is necessary to withstand the high pressures built up inside.

Old design

The combustion chamber was formerly drawn of spheroidized 1030 hot rolled steel and cold worked to obtain high strength. The aft end of the chamber was machined to provide a cone, three flat spots for locating stabilizing fins, and a seat for a graphite nozzle. Another purpose of machining was to reduce weight. There were three problems:

1. The seat for the graphite nozzle was made by machining a continuation of the drawn bore. However, this did not provide a continuous surface to support the nozzle because of a slight ovality in the drawn part. The graphite nozzle usually cracked in operation since it lacked support. The cracks frequently allowed hot gases to burn through the steel chamber and cause the rocket to malfunction during flight. In cases where the graphite did not crack erosion would occur, forming channels in the graphite and causing off-center thrust.

2. The welded fin studs were unsatisfactory because the heat of welding degraded the cold work structure in the 1030 steel of the combustion chamber. Threaded studs were considered but posed problems because of the thin section available for threads.

3. An o-ring seal between the graphite nozzle and an asbestos-phenolic tube liner failed because of high heat.

New design

All three fabricating problems encountered in the old design were solved by compression molding a glass-reinforced phenolic nozzle into the combustion chamber, using the chamber itself as a mold. Here's how reinforced plastics helped solved the problems:

1. Because the reinforced plastics material flowed and filled up any irregularities, machining of the seat was no longer required to match it to the bore of the drawn tube; the result is lower machining costs and fewer rejections.

2. Fin studs were placed into the chamber from the inside by a light press fit to the shoulder of the stud. The plastics molding completely covered the knurled heads of the studs, locking them into position and preventing them from turning.

3. The joint formed between the molded nozzle and the laminated tube liner eliminated the need for an o-ring.

Although some erosion occurs in the reinforced plastics nozzle, it is not as severe as in the graphite nozzle. The erosion is uniform about the combustion chamber opening and does not cause off-center thrust.

Plastics Packings Increase Efficiency of Cooling Towers

Citation

FLUOR PRODUCTS CO.

■ A new plastics grid packing—injection molded of high impact polystyrene or linear polyethylene—has a very high performance coefficient with a unit pressure drop comparable to that for a typical wood film packing and only slightly exceeding that for a typical wood splash packing (see table on p 148). In addition, the packing is very light in weight and has a relatively high proportion of void space.

Though developed primarily for use in water cooling towers, the packing lends itself to gas-or-vapor-to-liquid contact in many other applications, such as gas scrubbing towers and trickling filters. It can also be used as replacement packing to increase the efficiency of existing counterflow, induced-draft water cooling towers.

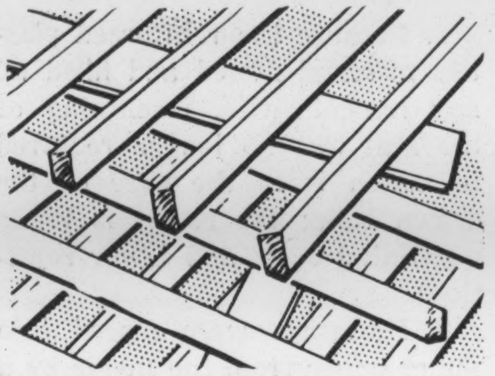
The packing consists of a square gridwork of vertical ribs 2 in. apart in both directions. Five spacers are provided on each unit. When installed, alternate layers are rotated 90 deg so the ribs are not in line in any two successive layers.

The polyethylene is used for special applications where greater chemical resistance is needed—particularly where hydrocarbon compounds are present in the circulating liquid.

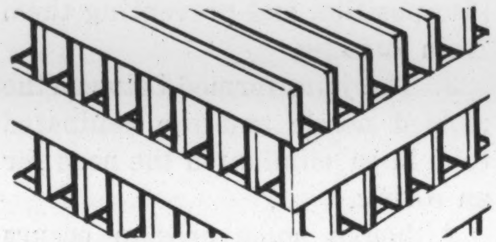
Why a new material?

In a counterflow water cooling tower, the water is in free fall through the packing grid while the air is drawn upward for maximum efficiency of water-air contact. Towers for air conditioning and refrigeration service use

Old

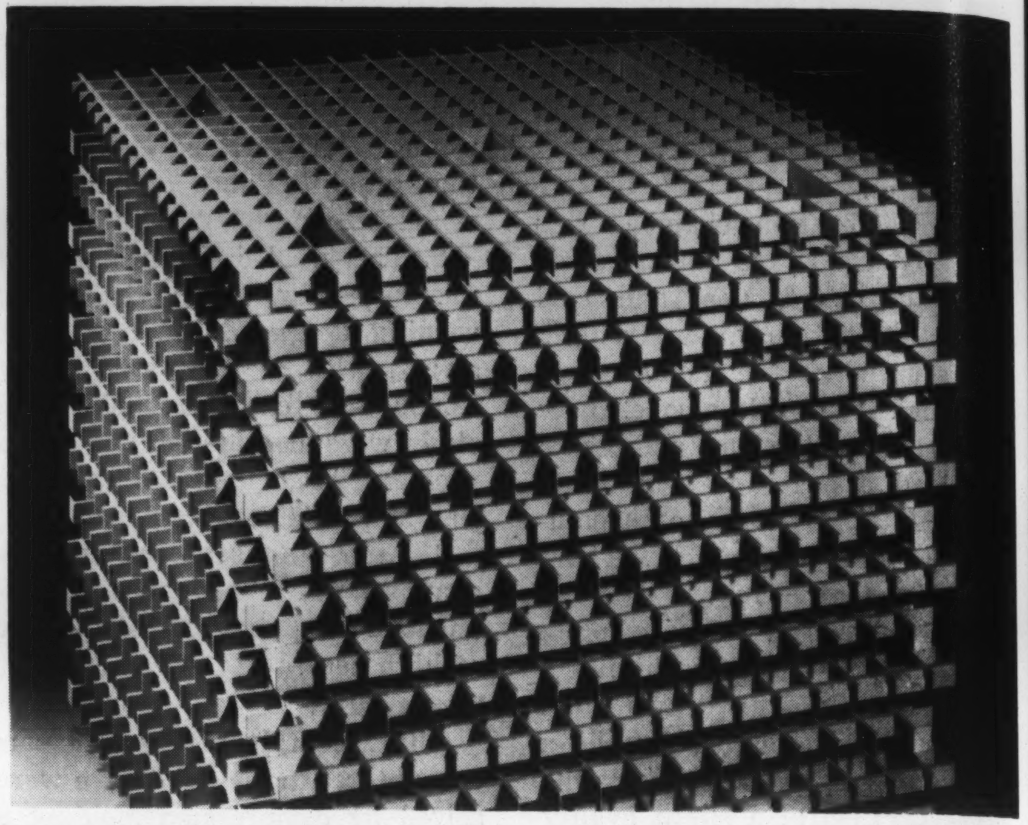


Wood splash packing—*open construction and economy, but low heat transfer.*



Wood film packing—*more efficient, but warpage and deterioration limit minimum thickness of slats.*

New



Polystyrene film packing—*resistance to deterioration, lighter weight, more open construction, more surface for higher efficiency.*

packings generally classified as either "splash" or "film" type.

The splash type is the most commonly used and consists of grid decks spaced 1 or 2 ft apart vertically to break up the free falling water. Most of the air-water contact takes place in the voids rather than on the packing surface. Although heat transfer is low, there are advantages of economy, ruggedness and low pressure drop.

The film type of packing, on the other hand, is highly efficient because transfer takes place as the water flows in a relatively continuous film over the packing surface. Research indicated that if certain limitations were overcome this type of packing could be competitive with splash packing, particularly on an annual cost basis.

The limitations lay in the nature of the material used. Standard film packing was of the redwood "egg-crate" type. Wood is susceptible to chemical and biological attack; this, and warpage, limited slat thickness to a minimum of $\frac{3}{8}$ in. Because the egg-crate design places slats only 1 or 2 in. apart, an appreciable portion of the tower volume was occupied by lumber, leaving relatively little void space for the passage of air.

For these reasons, a new material was sought that would allow a more open design, be resistant to deterioration, and not greatly increase the cost.

Materials and design

The materials investigated included cement-asbestos sheets, metal and plastics screens, plastics-impregnated paper, ceramic shapes, and thermoplastic resins in several forms. Polystyrene and polyethylene seemed to satisfy all conditions and to be most promising. Fabrication techniques investigated included extrusion, postforming of sheet, and injection molding.

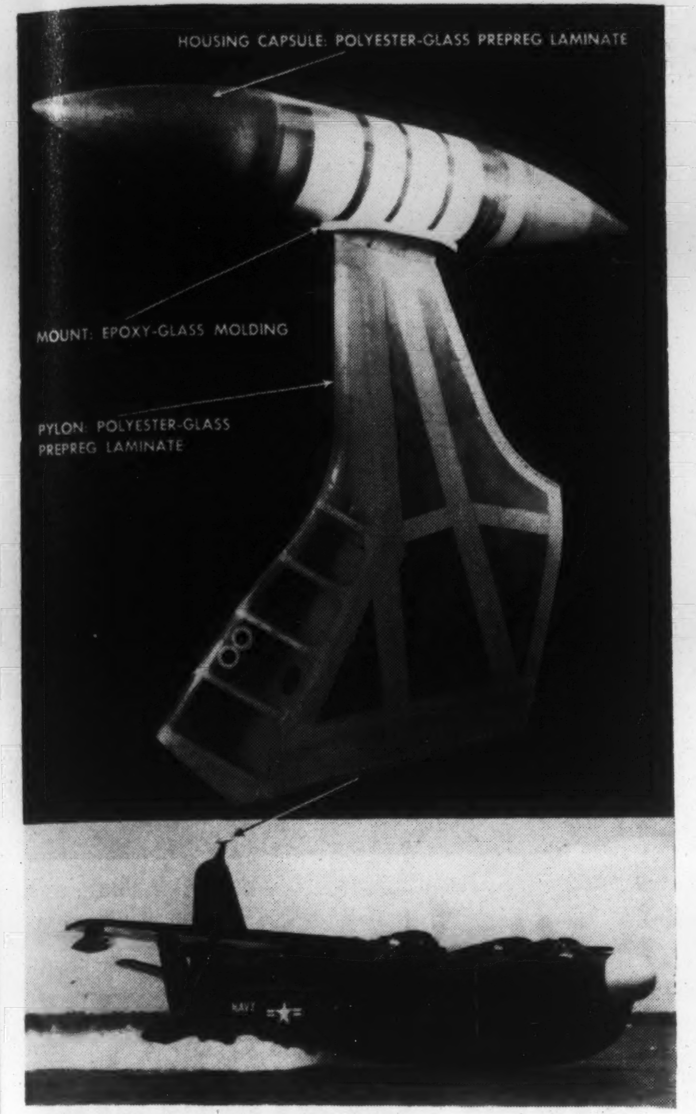
Theory pointed to the use of parallel vertical film surfaces for best efficiency with minimum pressure drop. Extruded hexagonal tubes in a honeycomb configuration denied theory because of unequal distribution through the vertical passages. Packings comprised of formed plastics sheets were capable of redistributing air and water in one direction, but vertical spacing was needed between elements.

The final design incorporates the most efficient vertical spacing, and uses splash strips added to the top ribs of each deck to catch drops which might otherwise elude several decks.

SEVERAL PACKINGS COMPARED AT ONE AIR AND WATER RATE[a]

Packing Type ➡	Ceramic Partition Rings[b]	Wood Splash[c]	Wood Film[d]	Formed Plastics Sheet[e]	Plastics Grid
Packing Pressure Drop, in. H_2O/ft	0.063	0.010	0.025	0.025	**0.024**
Enthalpy Transfer Coef, Btu/hr/cu ft/(Btu/lb)	380	70	245	270	**390**
Weight (wet), lb/cu ft	70	0.91	9.0	3.8	**2.15**
Void Space As Installed, %	53	98.4	81.3	94	**96.7**

[a] L=1000 lb/hr/sq ft; G=1500 lb/hr/sq ft.
[b] Stacked, 6 x 6 in. [c] Kelly-Swenson E.
[d] Slats, 2 x $\frac{3}{8}$ in., 2 in. ctr to ctr, lower edge serrated, Smith & Williamson.
[e] Dowpac HCS.


HOUSING CAPSULE: POLYESTER-GLASS PREPREG LAMINATE
MOUNT: EPOXY-GLASS MOLDING
PYLON: POLYESTER-GLASS PREPREG LAMINATE

Redesigned assembly *consists of housing capsule, mount and pylon.*

Citation

HARRY J. DOYLE,
Senior Engineer,
Materials &
Processes,
and
GEO. F. MOLBY,
Senior Engineer,
Structural Design,
Martin Co.

Prepreg, Epoxy Molding Cut Weight and Cost of Aircraft Structure

■ Use of a preimpregnated glass cloth-polyester laminate and a newly developed chopped glass-reinforced epoxy compression molding compound have provided the Martin P5M-1 Marlin seaplane with a greatly improved MAD (Magnetic Anomaly Detection) unit. The materials replace wet lay-up, glass-reinforced polyester laminates which were used throughout the old unit.

Each pound of the new structure supports 2.21 lb as opposed to 1.69 for the original design, thus providing an increase of 30% in structural efficiency. The redesign also provides substantial reductions in manufacturing costs, an increase in production rate, and simplified fabrication.

All three components of the unit — the housing capsule, the mount and the pylon—are now of reinforced plastics; the only metallic parts are fasteners used in assembly, and piano hinges and shear fittings which attach the pylon to the fin. The redesign permits the unit to meet more efficiently and economically its design requirements, i.e., 1) protect the electronic equipment, 2) support environmental loads throughout a temperature range of –65 to 160 F in a salt spray atmosphere, and 3) withstand aerodynamic loads, icing loads and inertia loads resulting from dynamic accelerations during take-offs, landings and flight maneuvers.

Prepreg moldings

The prepreg material is 181 glass cloth preimpregnated with polyester resin. This material is used in fabricating all detail parts —such as spars, ribs, doublers, frames and bulkheads—used in the housing capsule, and all details in the pylon except the honeycomb panels.

Unit cost of the redesigned housing and pylon is 55% lower than that of the original wet lay-up assembly. The higher initial cost of the prepreg material is more than offset by 1) reduction in scrap, 2) economies inherent in the procurement, handling, storage and inspection of only one material, and 3) elimination of clean-up time and equipment. Production rate is substantially increased and reproducibility of quality improved because of the controlled nature of the prepreg material.

Epoxy molding

The newly developed epoxy compression molding compound (Scotchply 1100) is supplied in the premixed, catalyzed condition with approximately 35% resin and 65% chopped glass fibers. It needs no treatment before molding.

Use of the molding material for the housing-to-pylon mount results in a 3½-fold increase in production rate. Extensive physical testing of the material indicates that its mechanical strength characteristics are comparable to those of the glass fabric-polyester laminates. The improved strength-weight characteristic of the material permits a 10% reduction in weight while increasing the strength of the unit.

More information on this redesign, and in particular the epoxy-glass molding compound, will be published in an article in next month's issue of MATERIALS IN DESIGN ENGINEERING.

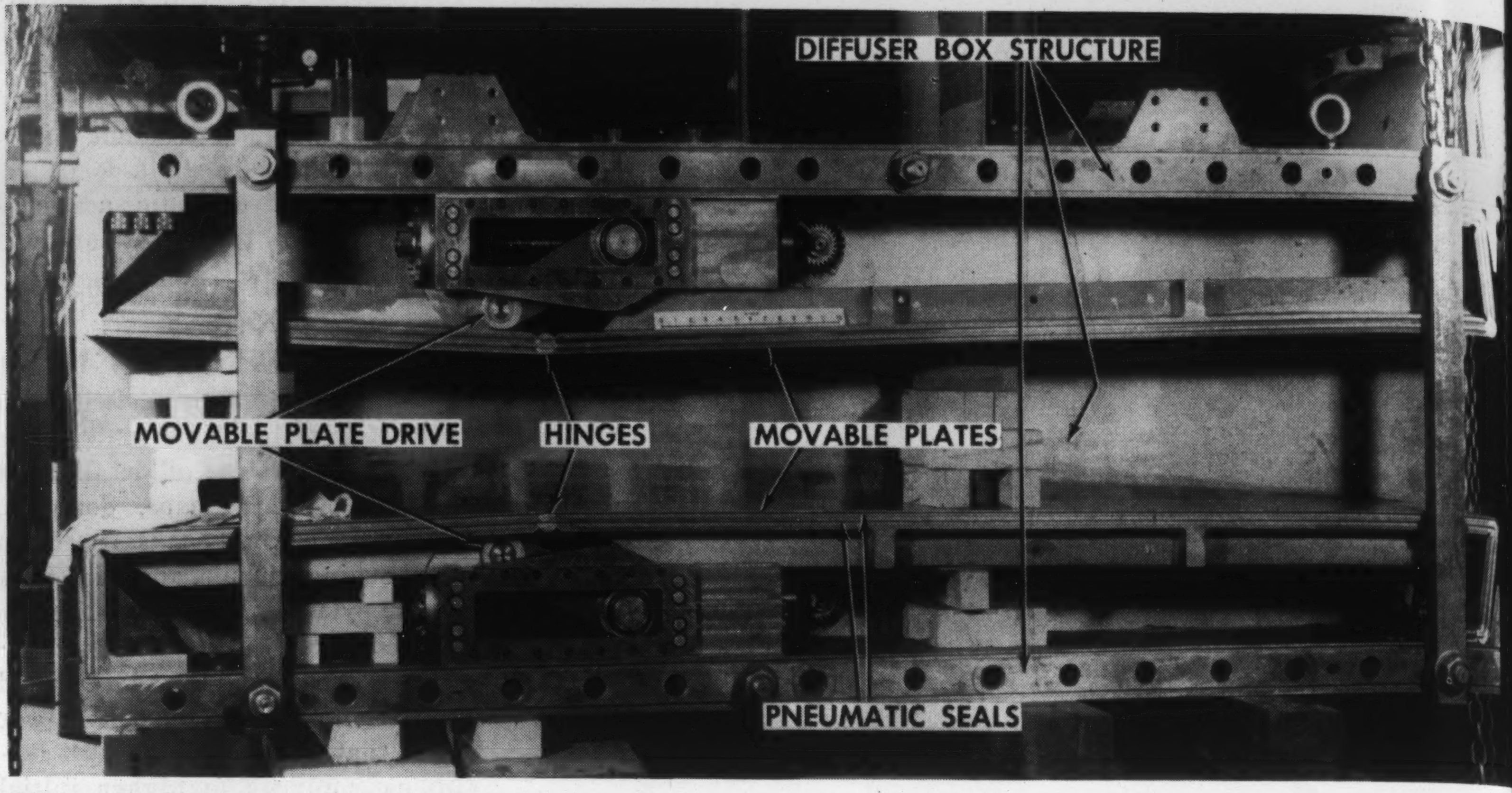


Fig 1—*Variable diffuser with slide plate removed.*

Careful Selection of Diffuser Materials Improves Wind Tunnel Performance

Citation
ROLAND DAUGHERTY, Associate Scientist
Rosemount Aeronautical Laboratories
Department of Aeronautical Engineering
University of Minnesota

■ The purpose of a hypersonic wind tunnel diffuser is to convert the kinetic energy of rapidly moving gases to potential energy. The diffuser is located downstream of the tunnel's test section and can be either a fixed or variable wedge design. A fixed wedge diffuser is usually designed to accommodate a limited range of Mach numbers, whereas a variable diffuser, such as the one discussed here, can accommodate a wide range of air velocities.

The problem of selecting the proper materials for a hot gas hypersonic wind tunnel is especially acute because of the high temperatures and air loads encountered. The diffuser is intended for use at temperatures up to 2500 F at hypersonic air velocities.

Key materials used in this new diffuser design are: chromium-molybdenum steel castings, metallized sandwich-type coatings, 4140 steel bar, hard chromium plate, 1020 hot rolled steel plate, metal-asbestos and silicone rubber extrusions, and type 195 aluminum alloy castings.

Component requirements

For simplification, the variable diffuser can be broken down into four basic components: movable plates, diffuser box, pneumatic seals and actuating mechanism.

Movable plates — The primary function of these plates is to vary throat area. They may consist either of thin flexible metal plates, or of upper and lower plate assemblies (see Fig 1), each hinged at the ends and the center to allow a change in cross-sectional area. Plate materials must have:

1. Good resistance to abrasion caused by foreign materials in the air stream.
2. Sufficient strength to withstand high air loads.

3. Good corrosion resistance (especially important in hot gas tunnels).

4. Low coefficient of expansion to permit close tolerances.

5. Good machinability for low manufacturing costs.

Diffuser box—The primary purpose of the diffuser box is to produce an accurate channel for the flowing air and to establish accurate boundaries for the movable plates. The two vertical plates of the box form the walls of the diffuser and come in contact with the edges of the movable plates shown in Fig 1. In general, the materials requirements for the box are the same as for the movable plates. In addition, the air flow surfaces must have accurate dimensions and a good finish.

Pneumatic seals—Because of the high pressure differentials involved, it is extremely important that no air be allowed to pass between the edges of the movable plates and the sides of the diffuser box. A double pneumatic seal is used between the edge of the movable plates and the sides of the diffuser box to prevent air leakage. The materials selected for these seals must be capable of withstanding 10 to 25% compression, and be compatible with lubricants used between the movable plates and the sides of the diffuser box.

Actuating mechanism—The actuating mechanism is used to control the motion of the movable plates and to control the cross-sectional area of the diffuser. Design of the actuating mechanism is fairly conventional, consisting principally of a modified truck transmission, a 15-hp motor, and suitable housings. Since it is located outside the air stream the mechanism is not exposed to any detrimental environmental conditions. It must, however, have sufficient strength to withstand the forces imposed on the plates.

Materials selected

Movable plates—Because of the possibility that very high operating temperatures might have an effect on steel weldments and joints, castings of chromium-molybdenum steel were selected for the movable plates. This steel best met the requirements of low thermal expansion, high structural strength and fair machinability.

Because of the temperatures encountered and the degree of thermal cycling (40 to 2500 F), it was necessary to use some type of coating to prevent the formation of rough, scaly surfaces. The coating selected is a sandwich type consisting of a nickel-chromium-boron base, an intermediate sealer and an aluminum overlay.

The base coating is sprayed over a rough machined surface to a thickness of 0.015 in. It is then heated to fusion temperature with an acetylene torch to insure total coalescence of the alloy. After application of a sealer, aluminum is sprayed on to produce a total coating thickness of about 0.040 to 0.045 in. After heating to 1200 F, the aluminum is converted to aluminum oxide which, through the catalytic action of the sealer, fuses with the nickel-chromium-boron layer. The resulting surface has a glossy appearance, is low in friction, and can be used to 2500 F.

Hot rolled, heat treated and stress relieved AISI 4140 bar steel is used for the hinge elements (Fig 2). This steel was found to best meet thermal and strength requirements. Each bar is machined to 1 mil under final diameter and given a ½-mil hard chromium plate. End brackets for the hinges are made from SAE 1020 hot rolled steel bar. Operating requirements for these parts are not too severe as they are located outside of the air stream and are not subject to extreme heating.

Diffuser box—SAE 1020 hot rolled steel was selected for the side plates primarily because of its good machinability and weldability. Comparatively thick sections are used to withstand the high air loading on the side plates and to minimize thermal distortion. As with the movable plates, all inner air flow surfaces are given a protective coating consisting of a nickel-chromium-boron base, an intermediate sealer and an aluminum overlay.

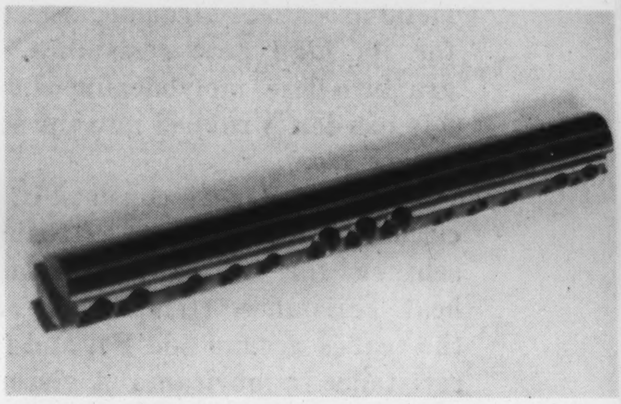


Fig 2—*Hinge elements are made from 4140 steel.*

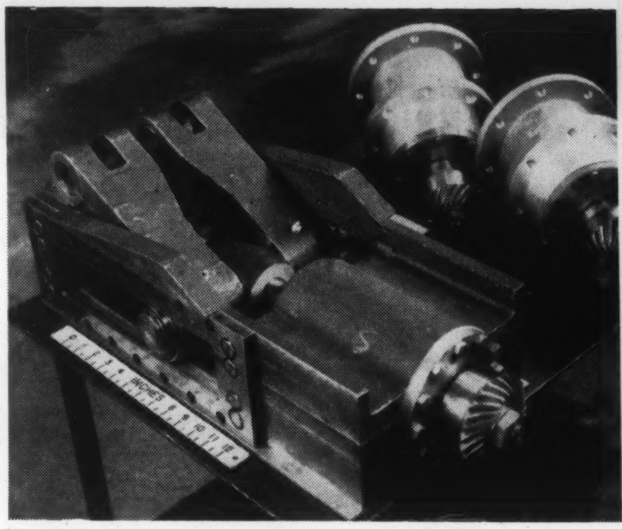


Fig 3—*Intermediate housing is made from aluminum casting alloy 195 and SAE 1020 hot rolled steel plate.*

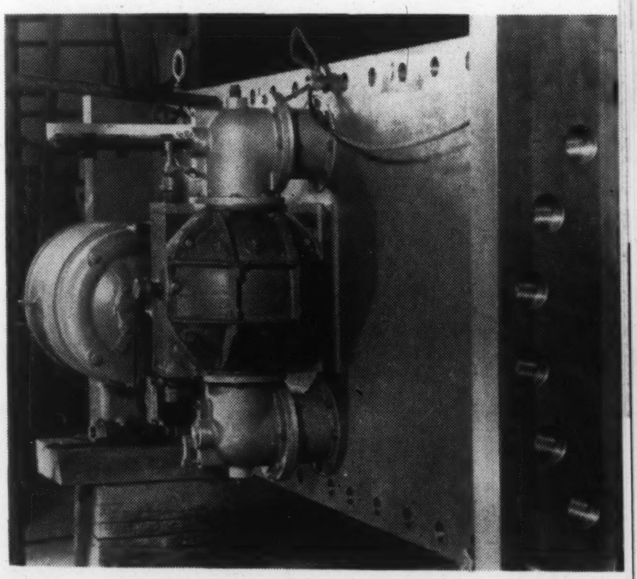


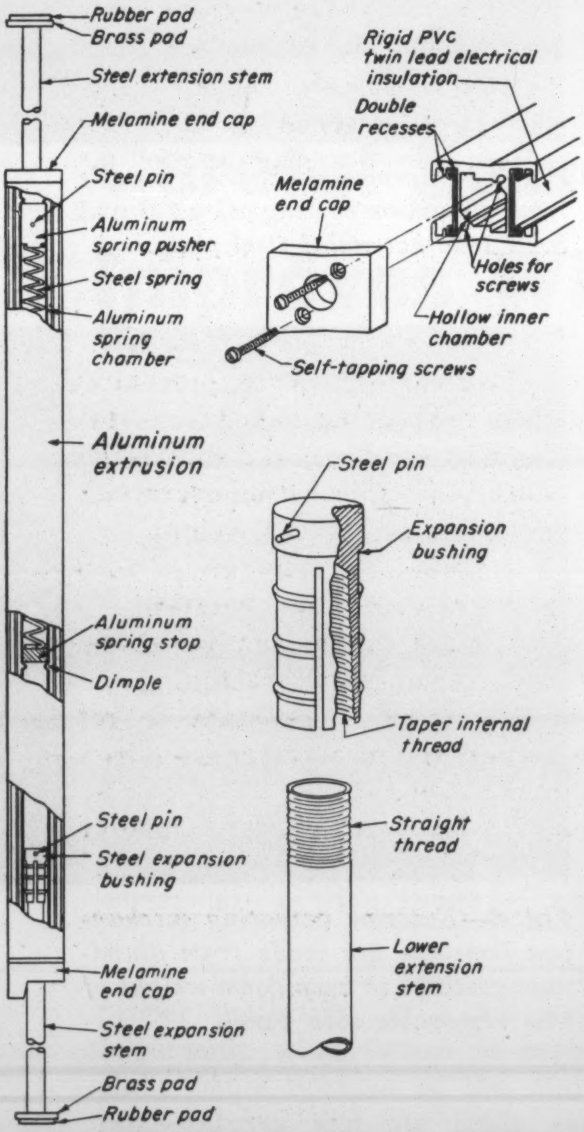
Fig 4—*Exterior actuating mechanism housings are made from aluminum castings to keep down weight of this removable side panel.*

Pneumatic seals—As shown in Fig 1, the seals run the entire length of the movable plates and through the ends of the hinge rods. The seal closest to the air stream consists of a rectangular metal-asbestos extrusion, selected for its high heat resistance. A graphite-base molybdenum disulfide powder is rubbed into the seal before use.

The second seal consists of a circular silicone rubber extrusion, selected for its high wear and heat resistance (temperature at the seal is around 500 F), and its resistance to lubricants. A viscous high temperature grease suitable for use at high pressures is used in contact with the seal. Hardness of the silicone rubber is 40 to 50 durometer. The groove in which it fits is machined shallow enough to allow 10 to 25% compression of the seal.

Actuating mechanism—The intermediate housing parts (Fig 3) consists primarily of castings of type 195 aluminum alloy and of chromium-molybdenum steel. The 195 alloy is also used for the exterior housings (Fig 4). These housings had to be light in weight, as the side panel to which they are fastened is frequently removed for maintenance purposes. The horizontal drive shaft running through the housings is made from 4140 alloy steel.

Ingenious Aluminum Extrusion Is Key to Unusual Lighting Unit


Rubber pad
Brass pad
Steel extension stem
Melamine end cap
Steel pin
Aluminum spring pusher
Steel spring
Aluminum spring chamber
Aluminum extrusion
Aluminum spring stop
Dimple
Steel pin
Steel expansion bushing
Melamine end cap
Steel expansion stem
Brass pad
Rubber pad
Rigid PVC twin lead electrical insulation
Double recesses
Melamine end cap
Holes for screws
Hollow inner chamber
Self-tapping screws
Steel pin
Expansion bushing
Taper internal thread
Straight thread
Lower extension stem

Cross section *of entire column assembly (left), end cap assembly showing double recesses and twin-lead electrical insert (top right), and expansion bushing detail (bottom right).*

■ A carefully designed aluminum extrusion has made possible a new, completely portable, floor-to-ceiling lighting unit. The unit, is described as a "fully electrified column, spring loaded at the top so that it supports itself between floor and ceiling." It can be installed in less than 5 min, and retails at about $50.

Four important criteria were set in the design of this unit. It had to be:

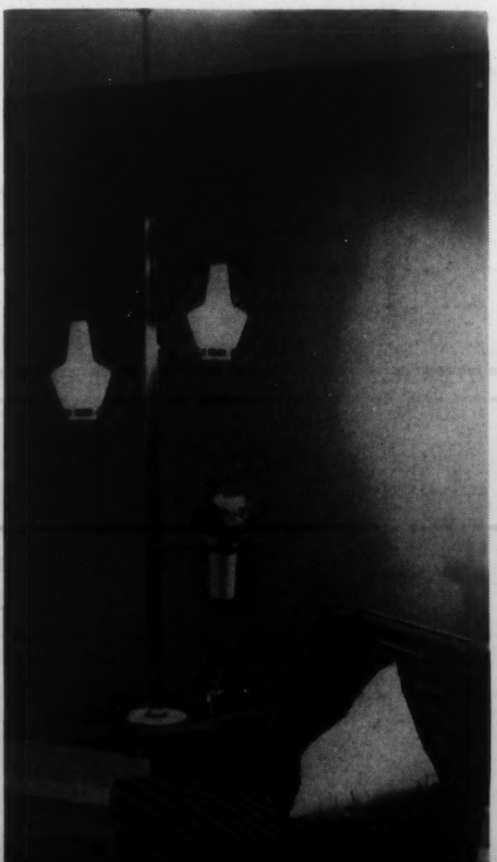
1. Exceptionally strong, yet light enough for easy installation.

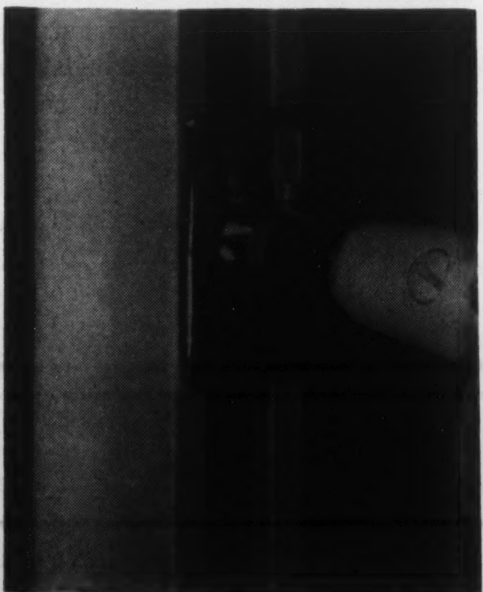
2. Safe, yet so designed as to allow attachment of any number of lamps at any point along either of two surfaces.

3. Flexible enough to be installed in rooms with ceiling heights of from 7 ft, 6 in. to 9 ft, 6 in.

4. Competitive with several others already on the market.

Citation
ANTHONY DONATO,
Industrial Designer
Lightolier, Inc.





Typical installation *of lighting unit and close-up of lamp attachment.*

Aluminum extrusion

Aluminum was selected for the main section of the column because it offered a high strength-weight ratio and because it could be attractively finished by either anodizing or enameling. Selection of the extrusion process with its almost unlimited choice of cross section made possible three key design features:

1. A hollow inner chamber to house the height adjustment mechanism. This mechanism consists of a spring chamber, spring pusher, spring, spring stop and expansion bushing (see drawing). The lower end of the spring chamber is dimpled to hold the spring stop in place. A pin in the spring pusher prevents rotational slip when the extension stems are threaded into the column.

2. Two continuous holes in the aluminum extrusion to allow fastening of end caps with self-tapping screws, thereby eliminating costly drilling and tapping.

3. Two sets of continuous double recesses on two sides of the extruded shape to retain the two twin-lead electrical inserts and to provide grooves for a mechanical twist-and-lock coupling device for attachment of the lighting accessories.

Other materials

Rigid PVC—Used for the twin-lead wiring insulation because of its good dielectric properties, dimensional stability and the ease with which it could be inserted into the aluminum extrusion without galling or fracturing.

Molded melamine—Used for the two end caps that separate the aluminum extrusion from the extension stems.

Steel tubing—Used for the upper and lower extension stems because of its structural strength, low cost, and ability to be brass plated, and because it allows good quality threads to be cut.

Aluminum bar stock—Used for the spring pusher, spring stop and spring chamber because of its low cost and ease of machining.

Steel wire—Used for the compression spring, specially designed to exert an upward force of 50 lb.

Cold rolled steel—Used for the expansion bushing located in the lower section of the basic column. The bushing incorporates a taper thread, a steel pin placed perpendicular to its axis, several sharp projections on the sides and slotted walls. Its function is to expand and bite into the inside walls of the spring chamber when the lower extension stem (which has straight threads) is threaded into it. The steel pin counteracts rotational force yet allows the bushing to expand, thereby permitting the lower stem to telescope for further height adjustment.

Brass bar stock—Used for the pads placed on each end of the extension stems because of easy machinability (free turning stock) and good polished surface.

Adhesive-coated rubber — Used for pads attached to the brass pads to contact floor and ceiling.

Dense Urethane Foam Is Fastening Edge for Sandwich Panels

■ Plastics sandwich panels used for portable arctic shelters must be joined in such a way that they provide a proper weather resistant seal. In developing such panels consisting of glass-reinforced polyester facings and foamed urethane cores, the Kawneer Co. developed a unique joint which utilizes a high density (12-14 lb per cu ft) urethane foam strip foamed in place against the edge of the panel. The strip is of tongue and groove design and has molded-in gaskets, a tapping plate for fasteners, and a chopped glass-reinforced polyester skin for reinforcement. (See Fig 1.)

Advantages

The new panel edging system offers many advantages not common to the more conventional sandwich panel edge band systems. The more important benefits are:

1. Material has good thermal insulating properties.

2. Edging is foamed in place, eliminating need for a mechanical attachment as well as routing or machining to size.

3. Fasteners and gaskets are molded firmly in place, preventing them from being pulled loose during field handling, and eliminating subsequent fabrication operations.

4. Material is lightweight.

5. Closed cell structure of foam provides good vapor barrier.

6. Edge profile can be altered without expensive machining.

7. Edging is resistant to rot, vermin and most adverse environmental conditions.

8. Material can be drilled,

Citation

D. E. PULSIFER,
Supervisor Defense Projects Research, and
B. L. WATERHOUSE,
Plastics Engineer
Kawneer Co.

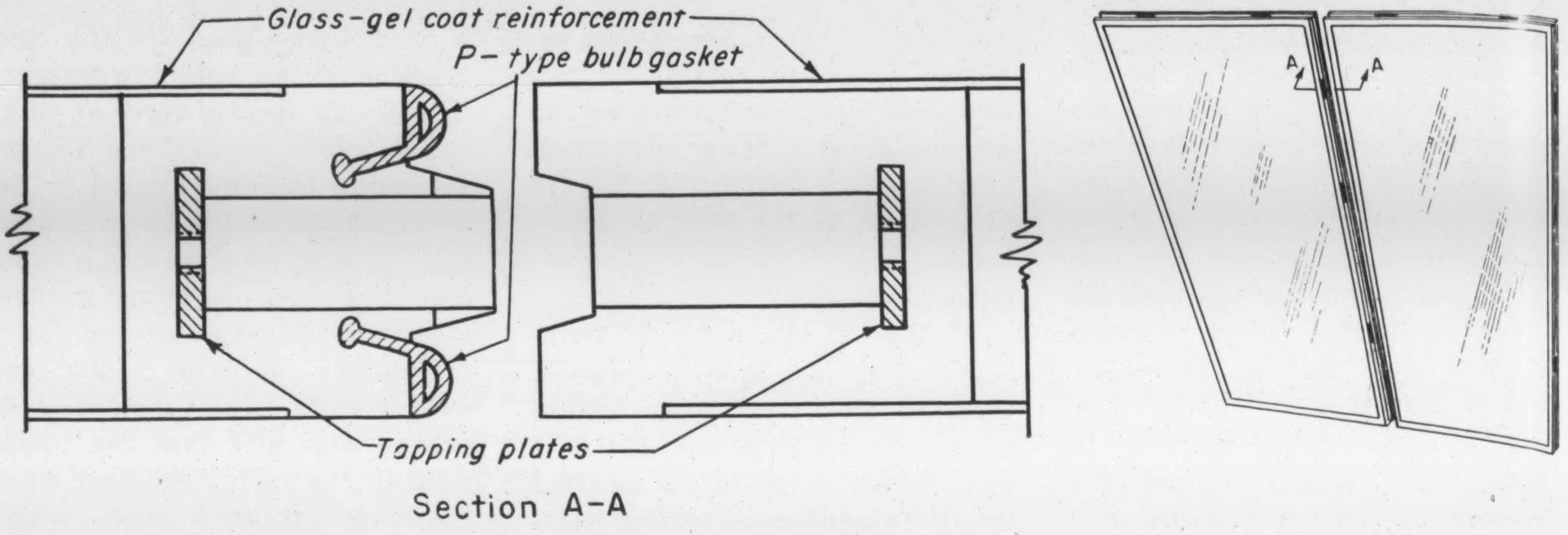


Fig 1—*Tongue and groove joint. Panels are in assembly position.*

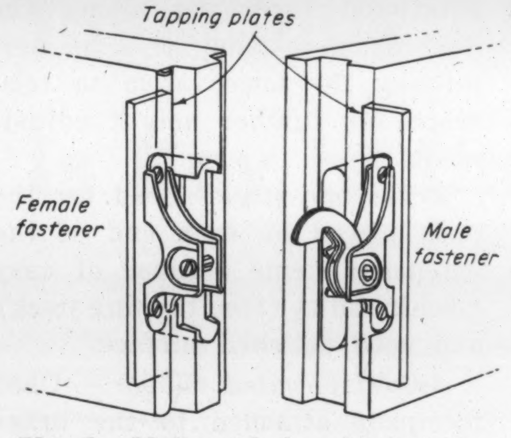
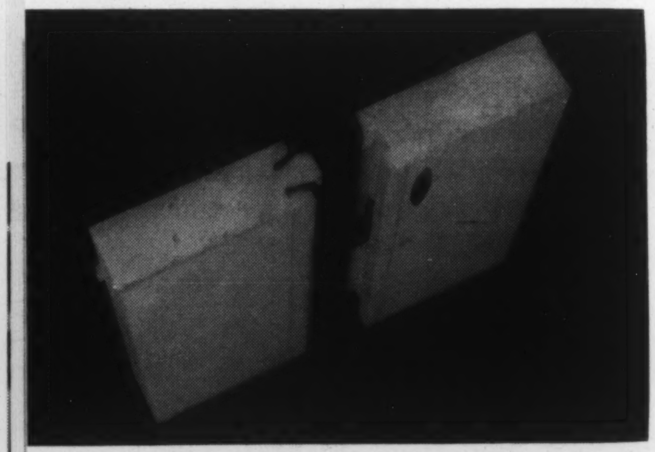


Fig 2—*Male and female fasteners are easily screwed into tapping plate which is molded into the edging strip.*



Cross section *shows urethane foam tongue-and-groove section with two P gaskets and fastener molded in.*

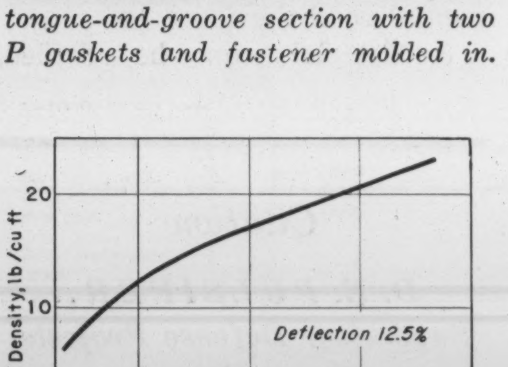


Fig 3—*Compressive stress required to compress urethane foam (Selectrofoam 6002 and 6003) by 12.5%.*

sawed and worked with most types of cutting tools.

Selecting the material

The more conventional edge banding materials, such as metal, wood or laminated plastics, were not considered desirable for this application because of either high thermal conductivity or excessive weight. It was felt the excellent thermal insulation characteristics of urethane foam, as well as its closed cell structure and light weight, would make it an excellent material for this application if sufficient structural strength and a reproducible fabrication process could be obtained.

Previous evaluations of panel fasteners indicated that an integral fastener mounted in such a manner as to apply a compressive load on the panel edge would be the most satisfactory sealing method. Since the stress imposed by the fastener would be greater than any other structural loads encountered by the edge members, compressive strength was considered the most critical property of the edging material. The compressive strength characteristic of urethane foam was found to be one of the material's best properties, and sufficient for the design requirements of the edge member. The accompanying curve (Fig 3) shows compressive load required for 12.5% deflection of foams of various densities.

Because of the low dent and impact resistance of the foam edge, reinforcement was necessary. Following the concept of a lightweight panel with no through-metal which would lower the insulating value of the panel, a reinforced plastics supporting coating was developed. It consists of a polyester gel coat and milled glass fibers. The foaming of the urethane edge takes place against the reinforcing edge, thus making it an integral part of the edging.

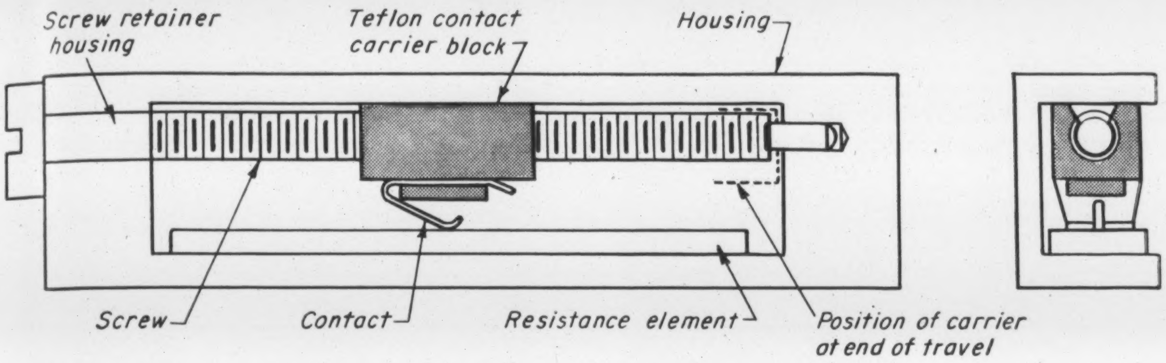
Gaskets and fasteners

A P-type bulb gasket with a long perforated tail which can be readily locked in the foam during the foaming operation is used. A metal tapping plate is also molded in place during the foaming operation. Fasteners can be readily installed by merely screwing them into the tapping plate embedded in the foam edge (Fig 2).

A variety of edge designs are possible with the foam-in-place fabrication technique. By machining various mold inserts to the desired shape and locating them in the panel mold, any number of panel profiles can be molded with no subsequent machining or trimming operations.

Foaming in place

In producing the edge on the prefabricated panel, the panel is placed in a table mold fitted with edge molds of aluminum bar stock and incorporating gaskets and other inserts as desired. The mold is coated with the catalyzed gel coat and sprayed with the milled glass fibers. The foam mixture is poured into the mold and the mold top installed. After the resin foams and cures, the panel is removed from the mold.


Screw retainer housing
Teflon contact carrier block
Housing
Screw
Contact
Resistance element
Position of carrier at end of travel

Cross section *of box trimmer shows Teflon contact carrier (shaded).*

Teflon's Cold Flow Used to Advantage in Resistor Box Trimmer

■ The cold flow properties of polytetrafluoroethylene (Teflon), usually considered a disadvantage, have been used to advantage in the design of a miniature contact carrier used in a resistor box trimmer. The box trimmer, an adjustable resistor in an insulated case, is small (1/8 x 1/4 x 1 in.) and demands good accuracy in the electrical-to-mechanical relationship for satisfactory operation.

The contact carrier is one of the most important elements in a box trimmer. In order to function properly it must meet the following requirements: 1) it must not backlash; 2) it must have positive positioning with regard to the resistor element; 3) it must stay put once it has been set; 4) it must be stable at temperatures up to 450 F; 5) it must be resistant to shock and vibration; 6) it must be flexible under excessive end loads; 7) it must not shred or flake onto the resistor element; and 8) it must have good electrical and insulating properties.

Why Teflon was chosen

Teflon meets all of the above requirements, and its cold flow characteristics provide the carrier with just the right amount of interference against the housing to give stability against shock and vibration during operation. Other reasons why Teflon was chosen:

1. The Teflon contact carrier provides an interference fit of 0.002 to 0.008 in. on the screw which is well within commercial tolerances.

2. Teflon cold flows enough to permit the driving screw torque to remain within the desired limits. The forces of mechanical interference and resistance balance out to flow provide an extremely satisfactory smooth sliding fit.

3. The stiffness of Teflon permits the carrier to establish positive thread engagement.

4. The low friction characteristics of Teflon permit adjustment of the contact carrier without distorting it. The low friction of Teflon on the threads is such that the distortion on the carrier is at a minimum and its stability is unimpaired.

5. The stiffness of Teflon permits the carrier to travel safely to the end of the screw without slipping off. When the carrier reaches the end, the screw continues to turn, spreading the Teflon block until it snaps back into place (in one revolution of the screw). This operation can be repeated many times at either end.

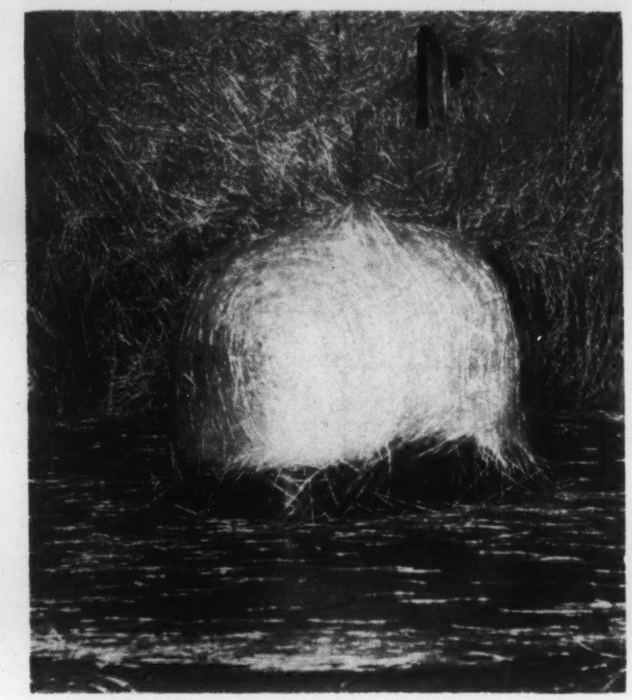
The Teflon part has performed satisfactorily for 10,000 cycles, whereas the life requirement of the part is only 100 cycles.

Citation

ROBERT I. PRUPIS

Consultant

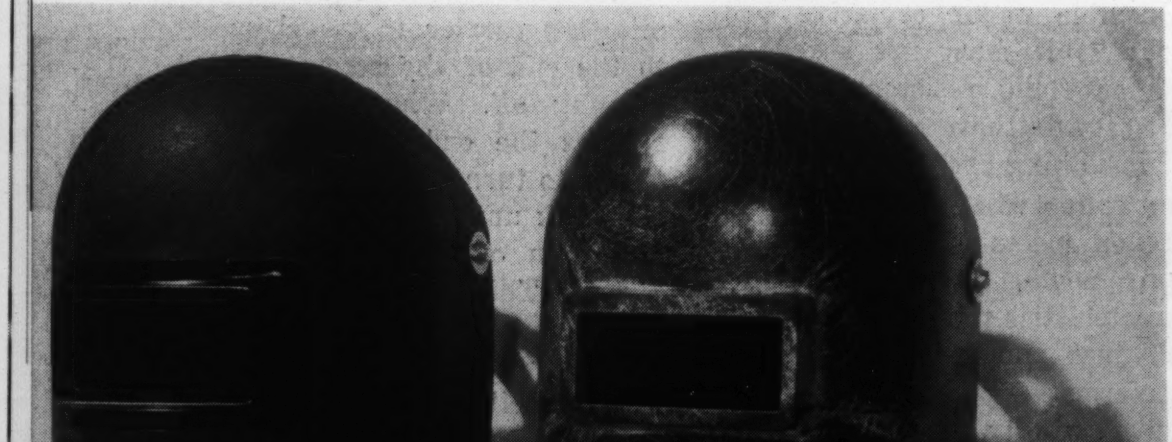
How the helmet is made →



1. Preform is shaped. *Glass fibers cut in 2¼-in. lengths are blown into top of preforming machine and drawn onto helmet-shaped screen by vacuum chamber beneath revolving table.*

2. Preform is dried. *After shaping, preform is sprayed with binder, then placed in drying oven. Preform includes shape of lens holder (not visible here).*

Glass-Polyester Welding Helmet Is Easier to Make, Easier to Wear



Old ***New***

■ A welding helmet protects against light rays, heat rays and spatter burn. Requirements, in addition to light weight, include resistance to flame, moisture and warping. Other considerations are appearance, comfort and cost. Changing from pressed, black vulcanized fibre to molded polyester-glass has resulted in welding helmets that are less costly to make, less likely to warp, and more comfortable to wear.

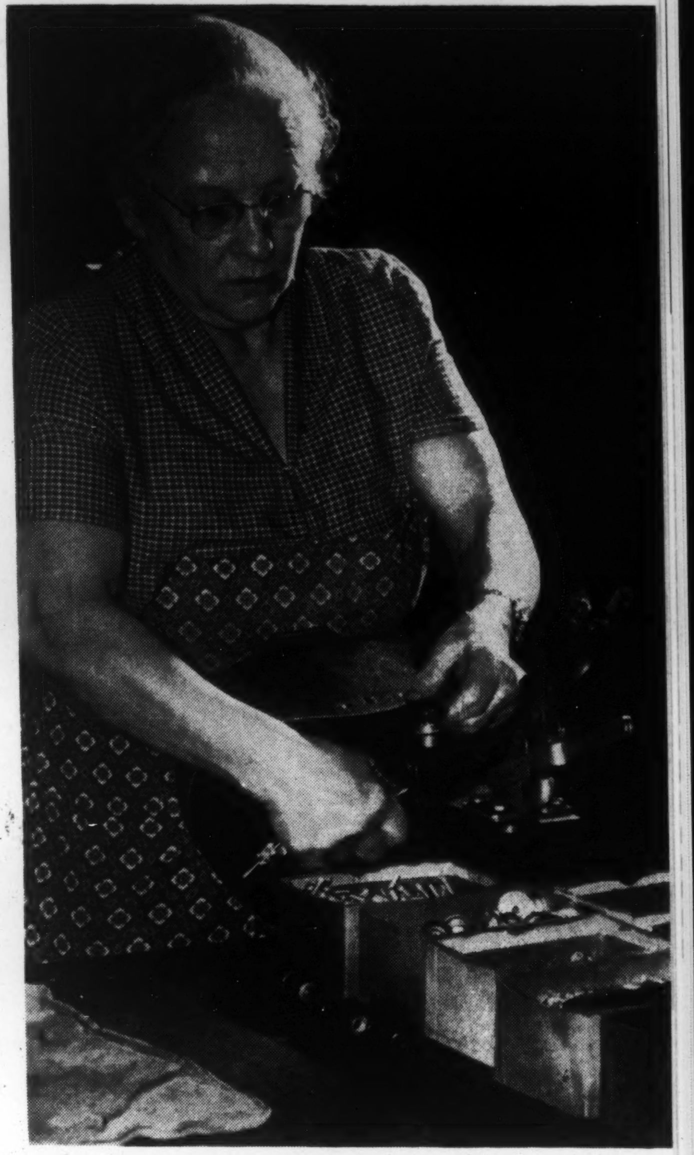
The new material consists of

Citation

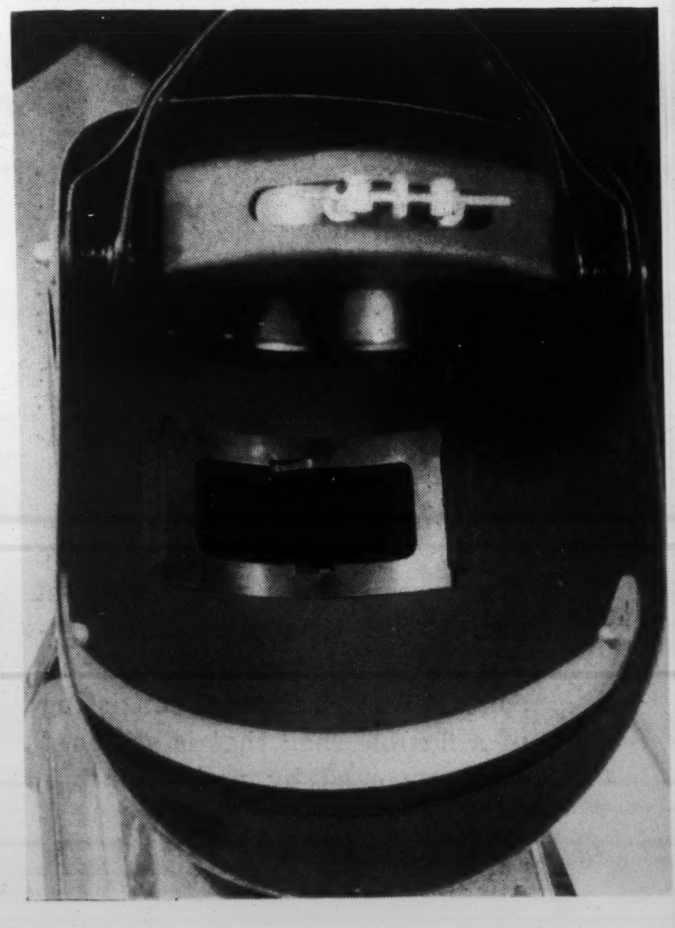
HOBART BROTHERS CO.

3. Helmet is molded. *Preform is placed in female mold, and colored resin and binder poured on top. Mold is closed and resin is cured at 250 F.*

4. Molding is finished. *Excess glass fiber is sanded off and the edge smoothed on a belt sander. Amount of excess is extremely small, sometimes inappreciable.*



5. Helmet is assembled. *Inside of helmet is sprayed with flat black paint. Then filter lens and adjustable headband are added. Interior close-up (below) shows attachable headband, and the filter lens retaining spring which is held by the boss molded in the helmet.*



polyester resin reinforced with glass fiber and containing a filler of China clay. The glass fiber is preformed to shape, loaded with the resin, molded and cured into a hard, infusible solid with a strength-weight ratio exceeding that of steel. The cured material has dimensional stability sufficient for precision work, is virtually corrosion proof, and has excellent thermal and electrical characteristics.

Advantages

1. Simpler fabrication. In the glass-polyester helmet, the lens holder is molded-in; in the vulcanized fibre helmet, the holder had to be assembled in a blanked hole. In addition, production of the fibre helmet was a time-consuming operation involving water soaking, heating, air drying for 18 to 24 hr, reheating, air drying for 48 hr, and final curing.

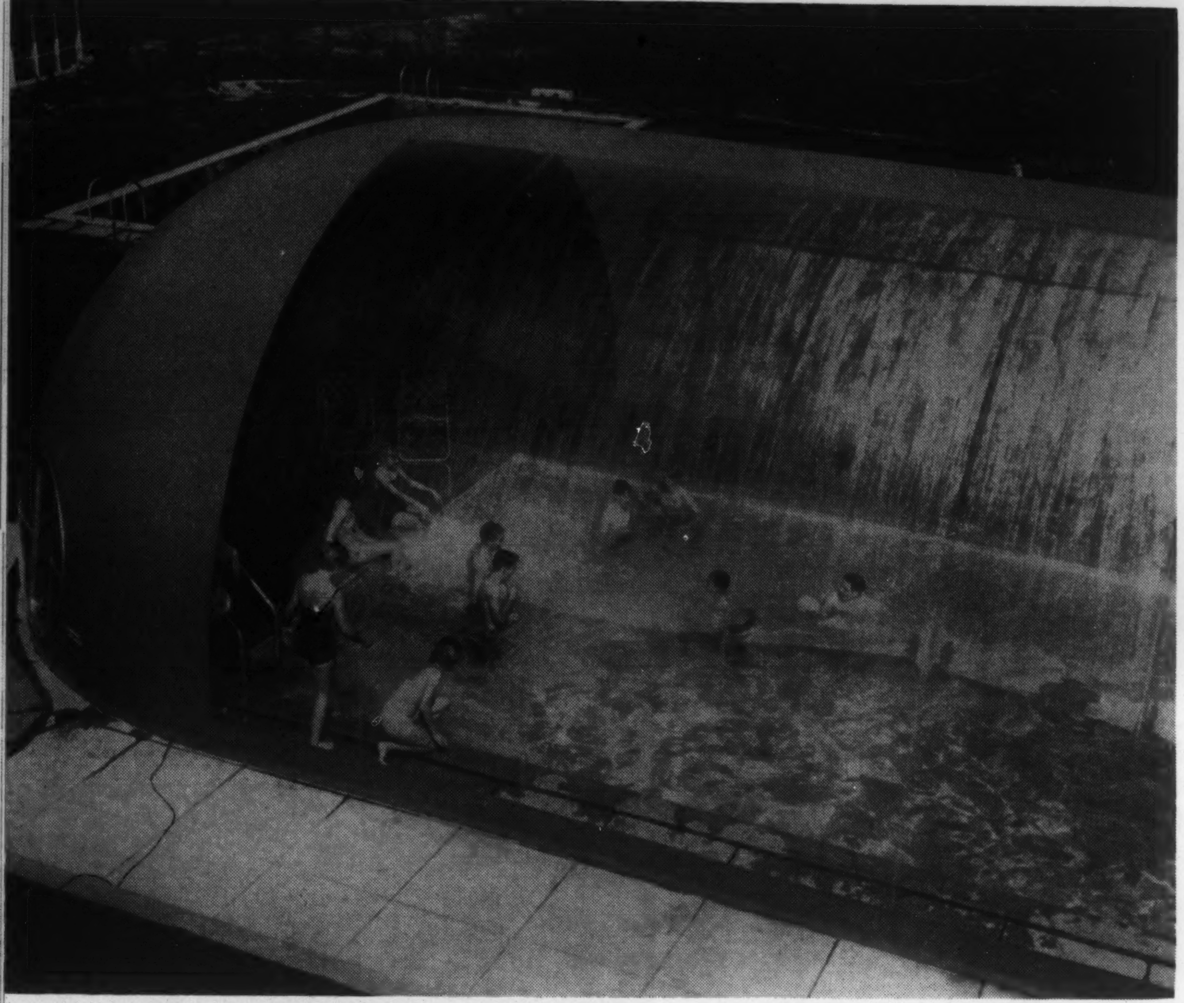
2. Lower materials cost. The vulcanized fibre was purchased in flat blanks; breakage during pressing averaged 5%, and there was 25% waste in material trimmed. In addition to these losses, in this case the plant did not use vulcanized fibre for any other purpose and had to purchase it at small lot prices. The plastics moldings, on the other hand, required negligible trim.

3. Resistance to warpage. The vulcanized fibre helmet could absorb as much as 25% of its weight in moisture. A helmet placed in 180 F water for 12 hr would flatten out (tending to return to its original shape) to the point of being unusable. Such a test has no noticeable effect on the shape of the plastics helmet, which will absorb less than 2% of its weight in moisture.

4. Greater comfort. The vulcanized fibre helmet was available only in heat-absorbing black, and thus was hot and uncomfortable. White and yellow helmets—available in the glass-polyester material—reflect 70% of the radiant heat, making the wearer more comfortable.

5. Varied colors. The plastics helmet is available in any one of six colors, providing the user with instant identification, as well as making it easier to spot workers in hazardous areas or among moving objects.

6. Easily cleaned. The surface of the plastics helmet is slick and easily cleaned.



Typical installation *shows how fabric and clear film are combined.*

Improved Mylar Film Makes All-Weather Swimming Pool Possible

Citation

BIRDAIR STRUCTURES, INC.

- A clear, tough, transparent film —made of improved Mylar— and vinyl-coated nylon fabric have been combined to form a portable, air-supported enclosure for an all-weather swimming pool.

New structural concept

The swimming pool enclosure is a case where a new structural concept led to a substantial improvement in a material. The new concept was a structure consisting of a flexible shell that is stiffened and supported by maintaining a small air pressure differential within the shell; no auxiliary supports (beams, columns, trusses or arches) would be required.

The shape selected for the pool was a half cylinder with spherical (quarter spheres) end sections. In addition to providing the maximum usable floor area, this type of structure has the advantage of being subject to somewhat lower impact pressures than is the spherical radome structure. However, since the flexible shell has no bending stiffness, it is subject to considerably greater distortion.

New structural materials

Two basic materials were required for the pool enclosure: one for the spherical end section and one for the cylindrical section. End sections had to be made of a strong, completely flexible, weather resistant material that could be economically fabricated, yet have long service life. Moreover, the material had to be available in attractive colors. Vinyl-coated nylon fabric proved to be completely satisfactory.

The materials selection problem inherent in the design of the cylinder section was more difficult. Requirements included: 1) transparency; 2) light weight; 3) resistance to degradation under outdoor exposure in all weather conditions; 4) puncture and tear resistance; 5) good flexural strength; and 6) high modulus of elasticity.

Until recently, no material was available that met these requirements. Although conventional Mylar polyester film had good physical characteristics and seemed at first to be practicable, it was found to become brittle after long exposure to ultraviolet light; as a result, it lost its strength and tear resistance.

One of the problems that plagues the design engineer is the unavailability of materials suitable to the requirements of a new design concept. As a result, potential improvements in existing products or possible replacement by superior products are often unrealized. In this case, rather than discard the idea, the designers worked with Du Pont (producer of Mylar) until a modification called "Weatherable Mylar" was developed. After prolonged testing, the new material was found to satisfy all requirements.

A limited number of reprints of this report are available at 50¢ each.

Properties of Phenolic, Epoxy and Vinyl Coatings[a]

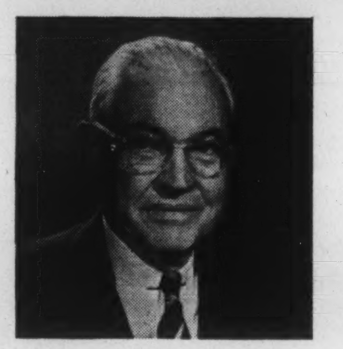
Coating Type ↓	Outstanding Characteristics	Physical Properties					Color and Gloss			Weathering Properties	
		Hardness	Abrasion Resistance	Adhesion	Flexibility	Toughness	Film Color	Color Retention	Gloss	Weather Resistance	Gloss Retention on Exterior Exposure
PHENOLIC											
Varnish[b]	Exterior durability; flexibility; low cost	F to G	F to G	G	G to E	F to G	F	F	E	G	P
Baking Solution (alcohol soluble)	Hardness; resistance to solvents, chemicals	E	G	G	P	P to F	P to F	P	E	F	P
Dispersion	Fast drying; resistance to lacquer solvents	F	F	E	F	F	F	F	P	G	F
EPOXY											
Epoxy Ester[c]	Good color; base resins can be used with inexpensive fatty acids; excellent flexibility, adhesion	F to G	F to G	E	E	F to G	G	F to G	E	F to G	P
Amine Hardened[d]	Properties of air-dry coatings approach those of baked coatings; excellent alkali resistance	G	F to G	E	F to G	F to G	F to G	F to G	F to G	F	P
Polyamide Hardened[e]	Flexibility, impact resistance	G	F to G	E	E	E	F to G	P to F	G	F to G	F
Epoxy-Phenolic[f]	Hardness; resistance to hot detergents, soaps; very good flexibility, adhesion	E	G	G	F to G	G	F	F	G	F	P
VINYL											
Solution[g]	Excellent color, flexibility, chemical resistance; tasteless, odorless	F	E	F to G	E	E	E[l]	E	G	E[l]	E
Plastisol[h]	Toughness; resilience; abrasion resistance; can be applied without solvents	F	E	E to cloth[k]	E	E	E[l]	E	F	E[l]	F to G
Organosol[i]	High solids content; excellent color, flexibility; tasteless, odorless	F	E	E to cloth[k]	E	E	E[l]	E	P to G	E[l]	G
Vinyl Acetate Latex[j]	Excellent color retention, viscosity stability, leveling properties	F to G if not over-plasticized	F to G	E to most substrates	G	G	E	E	F	G[l]	[m]
Vinyl Butyral	Excellent adhesion; produces excellent surface to which other coatings adhere	F to G	P	E to metals, cloth, paper and glass	E	E	E	E	[m]	E used as wash primer	[m]

[a] E=Excellent; G=Good; F=Fair; P=Poor. [b] Oleoresinous; properties depend on amount of oil and cooking procedure. [c] Properties depend on amount of oil. [d] Limited pot life; best resistance properties obtained by baking 15 min at 400 F. [e] Limited pot life; better than with amine catalyst. [f] Permits one package formulas. [g] Vinyl chloride-acetate copolymers; resins vary widely in compatibility with other materials. [h] Vinyl chloride-acetate copolymer and vinyl chloride resins. [i] Vinyl chloride-acetate copolymers; require grinding for good dispersions. [j] Can be thinned with water. [k] Requires primer for use on metal. [l] Pigmented. [m] Not normally used where gloss is a factor.

continued on p 163

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By John S. Davey

Select proper bolt diameter

An erroneous rule of thumb worth forgetting is that no bolt under $\frac{5}{8}$" should be used where fastened members are under stress. Yet bolts $\frac{1}{2}$-inch and smaller take plenty of external loading.

HOW TO LOOK AT IT

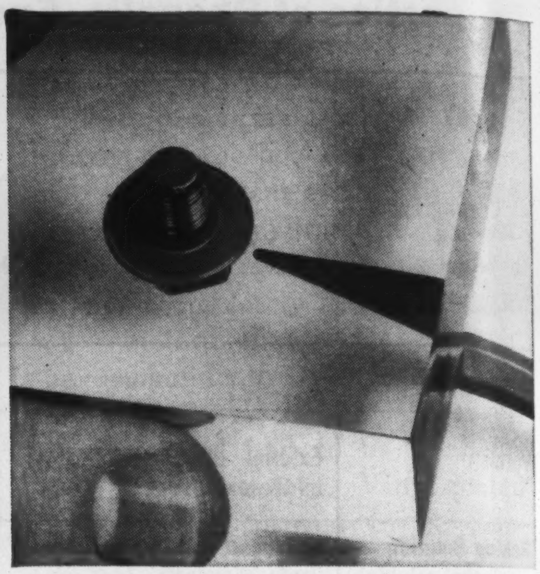
Primarily, you have to satisfy the stress requirements . . . the load. So select bolts on that same basis: the actual strength to sustain that load.

Calculating the strength requirements will tell you what bolt tensile, size, and number you need. If smaller bolts suffice, use them to avoid the penalty of overdesign. Holes can be smaller which means faster drilling and tapping. You have a chance to save materials since with smaller bolt holes, fastened members can often be made smaller too. You may also be able to standardize on a single size, saving assembly-line time.

SIZE VS. SAFETY

Remember that for a given grade of material, size tells you *capacity* of a bolt, not its *safety*. If you *tighten* a bolt to capacity, then you get safety. That's why a smaller bolt properly tightened is better and safer than a larger bolt sloppily tightened, especially where the loads are dynamic. Obviously, you reduce risk of under-torqued bolts as you reduce their size.

The new RB&W "SPIN SEAL" fasteners have spring-type washer with adhering flow-in seal . . . pre-assembled to standard machine or tapping screw.



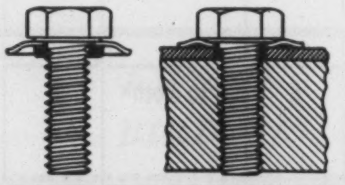
Flow-in sealant is confined by washer. Note how seal fills space under head and flows around and into threads in tightened SPIN-SEAL screw.

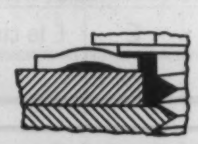
New SPIN-SEAL* screws give leakproof fastening

Here is a new type of composite fastener that seals by means of a unique flow-in sealant and washer.

ASSURES TRIPLE SEAL

Concave in shape, the heat treated springy washer confines and controls the flow of sealing compound. Tightening the screw forces sealant into various spaces around (1) threads, (2) head and (3) clearance hole to give hermetic sealing.





When screw is tightened the compound seals clearance hole and top thread; between washer and surface; between head and washer.

The washer has ability to conform to curved surfaces and still seal securely against hydrostatic pressures and wind driven water. Its spring tension and flat rim give the added advantage of dynamic metal to metal seal.

ONLY THE SCREW TURNS

Washer does not turn with the screw. This prevents twisting or tearing the sealing "gasket", marring of polished surfaces, or gouging of painted finishes.

The flow-in gasketing compound is plastic rather than elastic. Stable and non aging, it won't split or ozone-check under pressure. It gives controlled flow into clearance spaces. Compounds are available to seal out water or oil.

Send for Bulletin SS-1A which gives details on RB&W "SPIN-SEAL" fasteners. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

* T.M.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Come talk over your fastener problems with the RB&W Fastener Man in Booth 986 at the Design Show in Chicago, April 14-17.

For more information, turn to Reader Service card, circle No. 438

Properties of Phenolic, Epoxy and Vinyl Coatings—continued[a]

Coating Type	Chemical Resistance				Application			Typical Uses
	Solvents	Acids	Alkalis	Water (hot/cold)	Solvents Used	Application Method	Cure Method	
PHENOLIC								
Varnish[b]	P to ketones and esters; G to alcohols	G except to concentrated oxidizing acids	P	G/G	Aliphatic and aromatic hydrocarbons	Brush, spray, dip, roller, flow	Oxidation and polymerization; air dry or bake	Spar and floor varnishes; food can linings
Baking Solution (alcohol soluble)	E	E except to concentrated oxidizing acids	P	E/E	Alcohols, esters, ketones	Spray, dip	Polymerization by baking at 275-400 F	Solvent resistant linings for tanks, drums, food cans
Dispersion	Softens, but recovers without damage	F	F	P/G	Aromatic and aliphatic hydrocarbons	Brush, spray	Evaporation of solvent	Traffic paints and fast drying metal primers
EPOXY								
Epoxy Ester[c]	P to ketones and esters; G to alcohols	G except to concentrated oxidizing acids	F to G	F to G	Aromatic and aliphatic hydrocarbons	Brush, spray, dip, roller	Oxidation and polymerization; air dry or bake	Food can linings; floor varnishes; product finishes
Amine Hardened[d]	F to G to ketones and esters; E to alcohols	F	E	G/G	Mixtures of aromatic hydrocarbons, ketones and alcohols	Brush, spray, dip, flow	Polymerization; air dry or bake	Pipe coatings; chemical equipment
Polyamide Hardened[e]	P to ketones and esters; G to alcohols	F	E	P/F	Mixtures of aromatic hydrocarbons, ketones and alcohols	Brush, spray, dip	Polymerization; air dry or bake	Structural steel; paper coatings; collapsible tube coatings; coatings for molded phenolics
Epoxy-Phenolic[f]	G to E	G	F to G	G/G	Alcohols and ketones	Brush, spray, dip	Polymerization by baking at 300-425 F	Can and drum coatings; appliance primers
VINYL								
Solution[g]	P to ketones and esters; E to alcohols and aliphatics; aromatics swell	E to inorganic; P to acetic, formic and lower organic acids	E except ammonium hydroxide	G/E	Combination of ketones and aromatic hydrocarbons	Spray, roller	Solvent, evaporation; bake for best adhesion	Beer and food containers; bottle caps paper and metal foil; maintenance finishes
Plastisol[h]	P to ketones and esters; E to alcohols and aliphatics; aromatics swell	E to inorganic; P to acetic, formic and lower organic acids	E except ammonium hydroxide	Softens/G	Plasticizers such as phthalates, phosphates, glycolates	Spray, dip, roller, slush	Requires baking at 300-350 F for film fusion	Metal and cloth coatings; slush and dip molding; gasketing; foams
Organosol[i]	P to ketones and esters; E to alcohols and aliphatics; aromatics swell	E to inorganic; P to acetic, formic and lower organic acids	E except ammonium hydroxide	E/E	Combination of dispersants (plasticizers and ketones) and diluents (aromatic hydrocarbons)	Spray, dip	Requires baking at 300-350 F for film fusion	Cloth and wire coatings; product finishes
Vinyl Acetate Latex[j]	Resistant to aliphatic hydrocarbons	G to organic and weak mineral acids; P to conc mineral acids	G to weak alkalis; P to concentrated alkalis	Softens/G	Small amounts of plasticizer and high boiling solvent	Brush, spray, dip, roller, knife	Air or force dry	Interior wall paints and sealers; masonry paints; paper coatings; wood sealers and fillers
Vinyl Butyral	Softens but does not lose adhesion	P	P	F/F	Alcohols	Brush, spray, dip, roller, knife	Air dry, except when used with phenolics	Wash primers

Courtesy of Bakelite Co. Div. of Union Carbide Corp.

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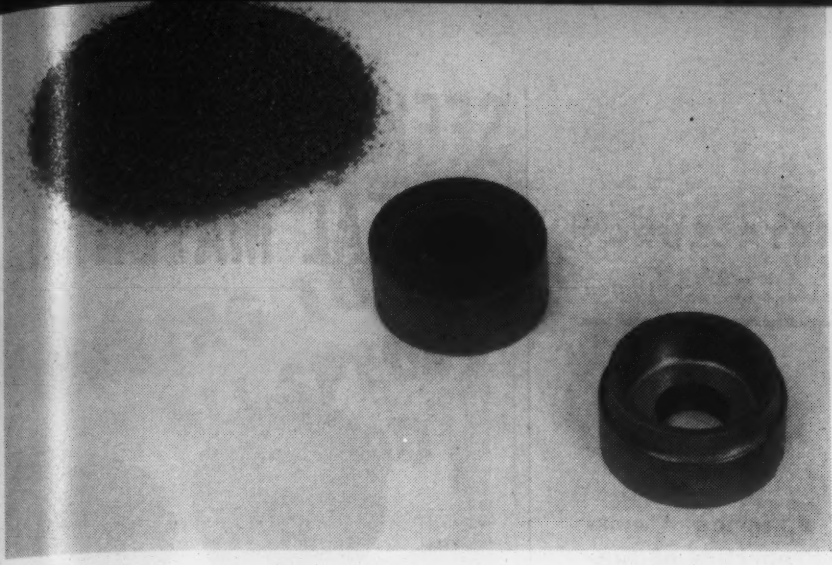
For more information, turn to Reader Service card, circle No. 469



PREVIEW

14th Annual MPA Meeting

and 1958 Powder Metallurgy Show

April 21-23, 1958

The New Sheraton Hotel in Philadelphia will be the scene of the 14th annual meeting of the Metal Powder Assn. to be held Apr 21-23. Running concurrently with the meeting will be the Powder Metallurgy Show at which more than 25 leading manufacturers will display their latest products and equipment.

The meeting

This year's technical session will feature 12 papers and a panel discussion on sintering furnaces and atmospheres. Subjects to be covered during the meeting include: powder metallurgy in Russia; metal powders in missile and rocket fuels; hard surfacing with metal powders; chromizing iron powder parts; and production of brass powder nuts and washers.

Five papers and a panel discussion are scheduled for Tuesday, the first paper starting at 9:30 a.m. and the last at 4 p.m. Seven papers will be given on Wednesday, the first starting at 9 a.m. and the last at 3:30 p.m. The program for the two day technical meeting, including time, title and author of each paper, is given starting on this page. All papers will be given in the hotel's Grand Ballroom West.

As in the past, registration, business sessions, and election of new officers of the Metal Powder Assn. will be held the first day of the meeting, Monday, Apr 21. The business session is for MPA members only and will be held all day Monday.

A reception and banquet will be held Tuesday evening, Apr 22. Mr. W. Laurence Le Page, president of the Franklin Institute, Philadelphia, will be banquet speaker.

The show

Company exhibits will open Tuesday, Apr 22, at 9 a.m. They will be open from 9 a.m. until 6 p.m. during both days of the meeting.

Exhibits will include new sintering furnaces, compacting presses and other equipment used in powder metallurgy. Representatives of the companies will be on hand to help in technical, supply and production problems. All exhibits will be in the Assembly Room and the East Ballroom of the hotel.

An alphabetical list of companies that will exhibit their products at the Powder Metallurgy Show appears on page 167.

Program

Monday, April 21

Registration
Business Session

Tuesday, April 22

9:00 a.m.

Powder Metallurgy Show exhibit opens

9:30 a.m.

9:30—**New Powder Metallurgy Applications in the Metal Cutting Field**—H. Trommelt, Spring Garden Institute

10:15—**Mechanical Filter Transducer Wire and Resonator Disks**—W. E. Whittington, Collins Radio Co.

11:00—**Market Development for Powder Metallurgy Parts**, M. Reid, New Jersey Zinc Co.

continued on p 166

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NEW

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Electrolytic 100 Mesh

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Electrolytic Iron
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For more information, circle No. 565

POWDER METALLURGY PREVIEW *continued*

2:00 p.m.

2:00—**Effects of Sintering Atmospheres on the Properties of Sintered Iron Compacts,** E. Kawasaki, Republic Steel Corp.

2:45—**Panel Discussion on Sintering Furnaces and Atmospheres**

Moderator: R. L. Harper, Harper Electric Furnace Corp.

Hydrogen and Dissociated Ammonia Gas—M. R. Ogle, Drever Co.

Exo and Purified Gas—H. Webber, Harper Electric Furnace Corp.

Endo Gas—N. K. Koebel, Lindberg Engineering Co.

4:00—**What Is Russia Doing with Powder Metallurgy?** C. Goetzel, New York University

6:30 p.m.

Reception and cocktail hour—Grand Ballroom West

7:30 p.m.

Banquet—Grand Ballroom East

Wednesday, April 23

9:00 a.m.

Powder Metallurgy Show exhibit opens.

9:00—**What Is Japan Doing With Powder Metallurgy?** Japan Powder Metallurgy Parts Mfg. Assn.

9:45—**Metal Powders in Missile and Rocket Fuels,** L. Frazier, Metal Hydrides, Inc.

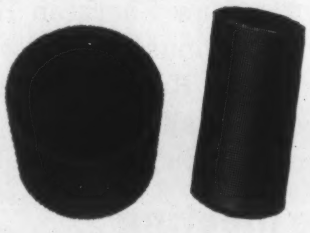
10:30—**Metal Powders for Barrel Finishing,** G. C. Madigan, Bendix Products Div., Bendix Aviation Corp.

11:15—**Slip Casting Metal Powders: A Commercial Reality,** H. H. Hausner, Consultant

SEEKING THE
IDEAL MATERIAL
FOR...

- Molds for powder metallurgy?

- Sintering boats?



- Crucibles, jigs, plates?
- Similar hot applications?

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Easily machined or fabricated, Speer carbon and graphite parts can be provided in almost any size and shape to your *exact* dimensional tolerances. If you have a design problem involving high temperatures, examine the advantages—and economies of Speer Carbon. Speer's knowledge and experience is yours for the asking—mail the coupon today for further details.

SPEER Carbon Co. St. Marys, Pa.

Please send information on carbon for use in

Name

Title

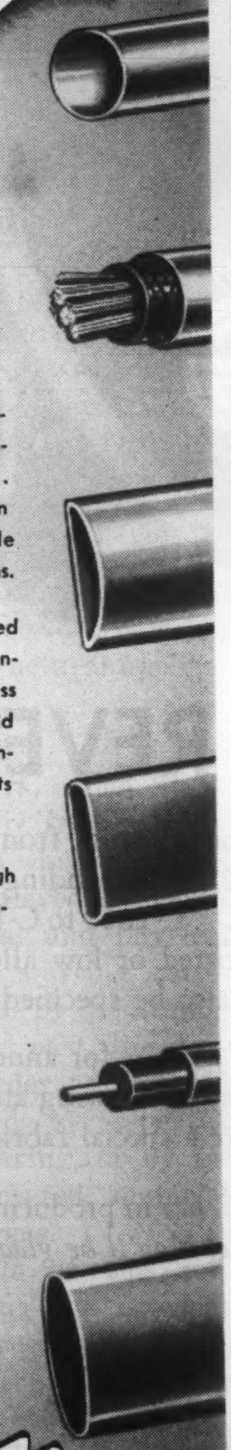
Company

Address

City Zone State

For more information, circle No. 571

TUBING TO MEET ALL SPECS .010" TO 1.000"



● Name your needs in accurately drawn seamless brass, copper, aluminum, nickel and nickel alloys, Ni-Span "C", phosphor bronze and nickel silver, and we have your answer.

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POWDER METALLURGY PREVIEW *concluded*

2:00 p.m.

2:00—**A New Viewpoint on Sintering**, F. N. Rhines, Carnegie Institute of Technology

2:45—**Chromizing of Iron Powder Parts**, R. P. Seelig, Chromalloy Corp.

3:30—**Production of Nuts and Washers from Brass Powder**, P. V. Tarr, Midwest Sintered Products Corp.

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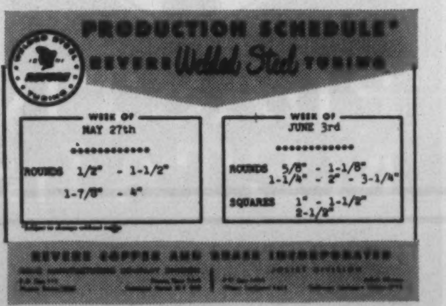

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WEEK OF JUNE 3rd
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1-1/4" - 2" - 3-1/4"
SQUARES 1" - 1-1/2"
2-1/2"

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High Density Metal Powder Parts

■ New metal powders developed by P. R. Mallory & Co., Inc., are said to make possible a variety of high density iron and steel powder parts whose properties are comparable to those of machine-wrought products—at substantial savings in time and cost. According to Mallory, the development " . . . constitutes a major breakthrough . . . [because it] . . . closes the gap that has thus far severely limited the broad application of ferrous powder parts in highly stressed structural applications."

Different approach

The new powders, called Steelmet, differ radically from conventional powders in that the final properties are achieved by modifying the chemical and physical properties of the starting materials, rather than by additional processing. In the past, the density of metal powder parts could only be increased by repeated pressing and sintering, or by infiltrating the sintered material with copper or brass.

Complete details of the new process for making the powders have not been released. However, the company says that by a "series of carefully controlled thermal, physical-chemical and mechanical steps," relatively cheap raw materials " . . . can be converted by a single pressing and sintering operation into a wide variety of iron alloy compositions which are at least 95% dense."

Properties

Steelmet powders are said to possess 1) high rates of inter-diffusion or self-diffusion of the metallic elements; 2) low bridging effect between powder particles in the compact before sintering; and 3) good flow characteristics and green strength.

According to Mallory, many new ferrous compositions have been tested and found to possess strengths of from 42,000 to over 200,000 psi, and elongations of from 36 to 1%. However, only four compositions are expected to be available for sale during 1958:

Steelmet 100—A 98% iron alloy described as a general purpose material having good tensile strength and excellent ductility; it can be carburized and heat treated.

Steelmet 101—A high nickel, ferrous alloy material possessing high tensile strength, good ductility and a yield strength-tensile strength ratio of about 0.9; this alloy can also be carburized and subsequently heat treated.

Steelmet 302—Composition of this material is equivalent to that of wrought 302 stainless steel. As-sintered tensile strength is said to be in the range of 75,000 to 90,000 psi; elongation ranges between 15 and 30%.

Steelmet 600 — A copper-containing ferrous alloy which can be precipitation hardened to increase tensile strength from 70,000 psi to 90,000 psi and still retain moderate ductility.

Applications

The most promising areas of application for the new parts are automotive, aircraft, electrical, appliance and business machine equipment. According to Mallory, the process will be used to produce such parts as gears, cams, levers, pawls and ratchets.

(more What's New on p 170)

PROPERTIES OF FOUR STEELMETS

Type ➡	Steelmet 100 (1 Mn-1Ni-Fe)	Steelmet 101 (9Ni-1Mn–Fe)	Steelmet 302 (302 Stainless)	Steelmet 600 (2 Cu-0.25 Ni-Fe)	
Condition ➡	As Sintered	As Sintered	As Sintered	As Sintered	Precipitation Hardened
Density, lb/cu in	0.27	0.27	0.26-0.27	0.27	0.27
Percent of Theoretical Density,	95-96	95-96	96-98	95-96	95-96
Tensile Strength, 1000 psi	50-55	78-82	75-90	68-70	85-90
Yield Strength (0.2% offset), 1000 psi	30-35	68-70	35-37	52-55	82-88
Elongation (in 1 in.), %	30-20	12-8	30-15	20-16	7-3
Modulus of Rupture, 1000 psi	Too ductile to break	260	182	220	226
Rockwell Hardness	B53-55	B88-90	B80-90	B78-81	B92-96
Impact, Strength (Izod), ft-lb	10	6	22	8	2
Impact Strength (modified Izod, unnotched), ft-lb	55	Bent only	90	Bent only	60
Fatigue Strength (10^7 cps), 1000 psi	27.5	—	35	37-5	—

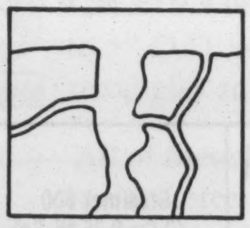
New molding technique — Lower manufacturing costs — as much as 25% lower in some instances—are claimed for the new plastics injection molding technique being used here. Called valve gating, the method was developed and patented by Columbus Plastic Products, Inc., which has granted an exclusive license to W. R. Grace & Co.'s Polymer Chemicals Div. According to Grace, the new technique is particularly useful in molding high density polyethylene and other thermoplastics.

The valve gate technique holds the plastics material in a reservoir, building up pressure that releases the valve and causes the material to gush into the cavity at high velocity. In conventional injection molding, the molten plastics material oozes through an opening into the mold cavity.

Valve gating is said to permit the molding of large, deep parts on relatively small machines. Other advantages: it permits the molding of parts that cannot otherwise be molded; it reduces molding cycles; it decreases scrap and rejects; it reduces finishing costs; it improves physical properties; and it reduces shrinkage.

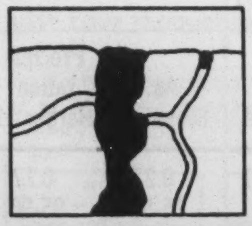
Porous Castings Made Airtight with Nonferrous Metal Powders

How castings are sealed



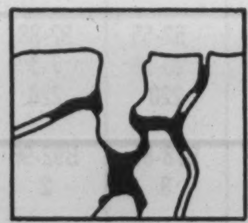
1. Before impregnation

Cross-sectional view shows how a casting looks before vacuum impregnation of metal powder combination.



2. After impregnation

Metal powder combination is vacuum impregnated into large pores of casting but not into small pores.

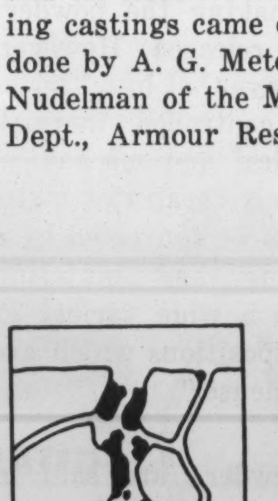


3. After firing

Firing at 1300 F melts the zinc, copper and aluminum powders and permits them to flow into the small pores.

■ Porous castings can now be made airtight by "microbrazing" with a combination of zinc, copper and aluminum powders. Furthermore, the impregnated castings retain their airtightness at temperatures of 1000 F and better—as high as 1650 F in one instance. A series of laboratory tests has shown that the metal powder combination seals some 30 times more effectively than presently used silicate-base materials which usually break down at temperatures much above 700 F.

The metal powder combination and an effective method for sealing castings came out of research done by A. G. Metcalfe and H. B. Nudelman of the Metals Research Dept., Armour Research Founda-



***Silicate-base** impregnants fail to seal pores because they shrink in drying operation.*

tion. A brief description of their work follows.

Why metal powders?

The two researchers chose metal powders as an impregnant because metal powders withstand high temperatures and do not break down in the presence of oil, water and steam as most commercial impregnants do. Another reason for the choice: molten metal powders run into the narrowest part of the pore by capillary action and insure sealing properties in the event of surface wear.

How castings are sealed

A metal powder combination of 80 zinc, 10 copper and 10% aluminum (melting point, 720 F) seems to provide the most effective seal when a concentration of 78.5% solids (in isobutyl alcohol is used. The powder impregnant suspended in solution is introduced into a vacuum chamber where the pores of a casting to be impregnated have been evacuated. A pressure of 100 psi is then applied to force the suspension into the pores of the casting. After vacuum impregnation the casting is fired at a temperature of 1300 F for 40 min.

For plant use, the flammability of alcohol may be a drawback; however, less flammable vehicles, or even water with corrosion inhibitors, may be used. Techniques and equipment used with commercially available impregnants may be adapted to suit the new material. A brief survey indicates that the process is competitive in cost with presently used techniques.

Effectiveness of impregnant

To evaluate the effectiveness of the impregnant, Metcalfe and Nudelman measured air leak rates of an iron powder disk with 25% porosity at various pressures.

Before impregnation the highly porous disk had a leak rate of 510 cu in./sq in./sec of air under a pressure drop of 25 psi; after impregnation this value was lowered to 1.2 cu in./sq in./sec of air. The leak rate for water was less than 0.000007 cu in./sq in./sec. Castings impregnated with the metal powder combination were sealed about 1000 times more effectively against water than castings impregnated with silicate-base materials.

A group of commercial investment castings made of type 304 stainless steel was tested with and without an impregnant. Castings without an impregnant had a leak rate of 0.24 cu in. per min, whereas metal powder impregnated castings had no measurable air leak. The commercial castings had been put through the following sequence of operations: 1) sand blasting; 2) sodium hydride treatment; 3) first machining; 4) stress relief annealing; 5) second machining; and 6) honing.

Results of tests performed on commercial castings indicate that typical ferrous and nonferrous porous castings may be completely sealed with the metal powder impregnant.

Teflon Resin Easier to Extrude; Available as Film and Powder

by R. S. Mallouk and W. B. Thompson

■ A Teflon fluorocarbon resin that can be processed on standard plastics extrusion equipment will soon be available as extrusion powder and as film from E. I. du Pont de Nemours & Co., Wilmington, Del. Called Teflon 100X FEP fluorocarbon resin, the new material has been under evaluation since its introduction in late 1956 (see MATERIALS & METHODS, Nov '56, p 161).

The resin, produced by polymerizing tetrafluorethylene and hexafluoropropene, softens at about 545 F and is readily extruded at temperatures of 650 to 740 F. Its low melt viscosity permits the melt extrusion of wire coatings, rod and tubing; the blowing of bottles; and rapid heat sealing.

Teflon tetrafluoroethylene resin cannot be molded on conventional equipment since it has no liquid flow stage; it is molded by a combination of compression and sintering processes that are somewhat analogous to those used in producing powdered metal parts.

Since the new type of Teflon is much easier to process than conventional Teflon, Du Pont has been evaluating it to see how well it performs when compared to conventional Teflon. Our findings, summarized in this article, indicate it has properties very similar to conventional Teflon. It has good electrical properties over a wide range of temperatures and frequencies; it is capable of resisting temperatures of 400 F and higher for long periods of time; it remains tough over a temperature

TYPICAL PROPERTIES OF TEFLON RESINS

Type ➡	6[a]	100X
PHYSICAL PROPERTIES		
Specific Gravity	2.2	**2.1**
Water Absorption, %	0.0	**0.0**
Melting Point (Crystalline), F	620	**545**
Burning Rate	Nil	**Nil**
MECHANICAL PROPERTIES		
Tensile Strength, psi	3000	**3000**
Elongation, %	360	**370**
Tensile Impact Strength, psi	400	**800**
Flexural Modulus, psi	78,000	**82,000**
Durometer Hardness	D 65	**D 55**
Heat Distortion Temp, F		
264 psi	—	**129**
66 psi	248	**162**
Coef of Friction Against Steel	0.025	**0.09**
Taber Abrasion (1000 gm, CS-17 wheel), mg/1000 cycles	—	**13**
Brittleness Temp, F	–148	**–130**
ELECTRICAL PROPERTIES		
Dielectric Strength, v/mil	500-2000	**2000-4000**
Volume Resistivity, ohm-cm	$>10^{15}$	$>10^{18}$
Dielectric Constant	2.0	**<2.1**
Dissipation Factor	<0.0003	**<0.0003**

[a] Extrusion grade (50-82% crystallinity).

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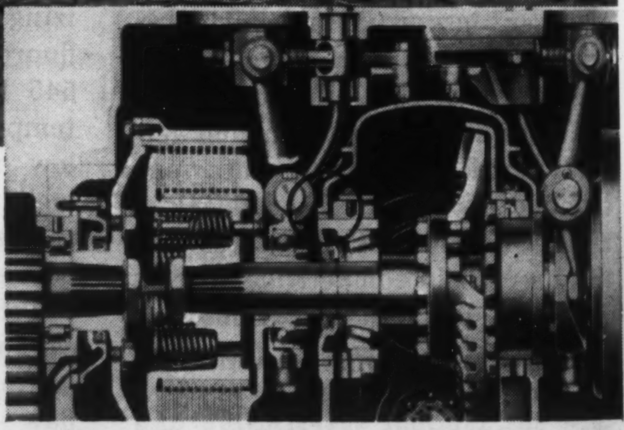

CUTAWAY of a Caterpillar No. 955 Traxcavator to show one of the spots protected by seals of American Felt.

But vital innards are kept grit-free and oil-tight with seals of AMERICAN FELT

The Traxcavator, made by Caterpillar Tractor Co., is called on to handle some mighty tough jobs. Logging, grading, loading gravel and dirt are just a few. Under these conditions even the best-made engines and machines need their vitals protected against grit, dust, water and mud, and at the same time have the oils and greases kept grit-free and sealed in. To do this dual job of keeping out dust and grit and keeping in oil and grease, Caterpillar Tractor Co., Peoria, Illinois uses seals of American Felt . . . in their D4 Tractor, No. 955 Traxcavator shown and other pieces of equipment . . . to insure reliable performance and long life.

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range of -300 to 400 F; and it resists most chemicals.

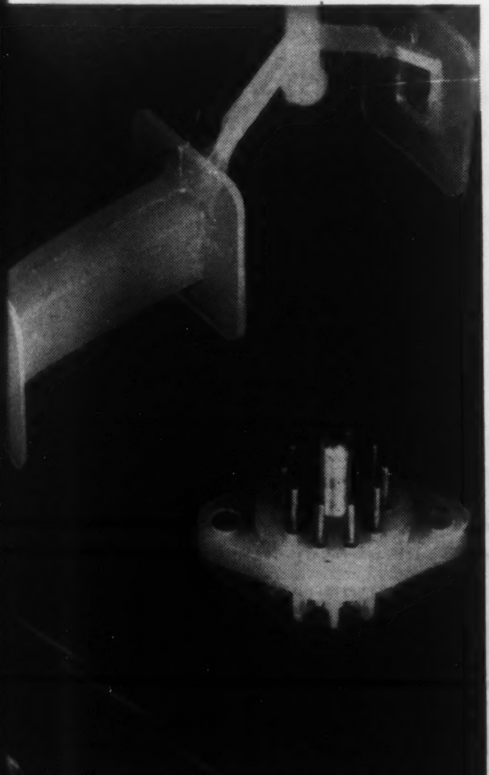
Potential uses

These properties indicate the resin can be used to fabricate a wide variety of parts for use in the aircraft, missile, electronic, electrical, chemical and petroleum industries; such parts include wire insulation, jacketing, tubing, gaskets and diaphragms. Because it has good weather resistance, Teflon 100X can be used as film for outdoor uses, such as solar stills and greenhouse covers.

Properties

The unique combination of electrical properties, chemical inertness, low permeability and excellent weather resistance of Teflon 100X is attributed to its completely fluorinated structure. The chemical description of the new resin, fluorinated ethylene propylene (FEP), has been adopted to distinguish it from conventional Teflon, tetrafluoroethylene (TFE).

Wire insulation, *hollow shapes and other parts that can be melt processed from new Teflon resin.*



Teflon vs Fluids

These fluids do not affect Teflon 100X at 212 F (aged 7 days):

Skydraul hydraulic fluid
Acetophenone
Benzene
Carbon tetrachloride
Ethanol
Hydrochloric acid (20%)
Piperidine
Sodium hydroxide (50%)
Sulfuric acid (30%)
Red fuming nitric acid

1. Physical properties — Like conventional Teflon, the FEP resin has the same anti-sticking properties and the same low coefficient of friction, a characteristic of completely fluorinated polymers. Both Teflon 100X (FEP) and conventional Teflon (TFE) are very similar in specific gravity, ultimate tensile strength, elongation, yield strength, flexural modulus, hardness and brittleness temperature. Teflon 100X has higher impact strength, but conventional Teflon has higher flex life, higher heat distortion temperature, and higher crystalline melting point.

2. High temperature properties —Teflon 100X retains useful mechanical properties over a temperature range of -300 to 400 F. The resin showed no evidence of degrading during 4000 hr of exposure in a circulating air oven at 410 F, and melt viscosity of the polymer remained essentially unchanged throughout this 4000-hr exposure. Similarly, tensile properties and toughness are retained even after long exposure times at 400 F, indicating that crystallization has little effect on mechanical properties.

3. Electrical properties—Since both Teflon 100X and conventional Teflon are fluorinated polymers, their electrical properties are essentially the same. Dissipation factor is less than 0.0003; dielectric constant is less than 2.1; volume resistivity is greater than 10^{18} ohm-cm; and dielectric strength ranges from 2000 to 4000 v per mil, depending on the thickness of the part.

4. Chemical resistance—Retention of tensile strength was used to measure the resistance of Teflon 100X to chemical attack. Tests show that the resin does not change in tensile strength when exposed to a number of organic and inorganic materials for 8 hr at 400 F. Even after 120 hr at 400 F, Teflon 100X resists the action of Skydraul hydraulic fluid (phosphate ester), acetophenone, pyridine, 20% hydrochloric acid, and 30% sulfuric acid.

5. Permeability — Permeability of Teflon 100X to most reagents is quite low, particularly to 98% sulfuric acid, 20% hydrochloric acid, and 50% sodium hydroxide.

6. Weather resistance — Accelerated aging tests indicate that Teflon 100X may be used outdoors for a period of ten years without any changes taking place in its physical properties. Results of aging tests:

a. Accelerated aging for 5000 hr in a Weather-O-Meter does not alter the physical properties of Teflon 100X.

b. Exposure to high intensity

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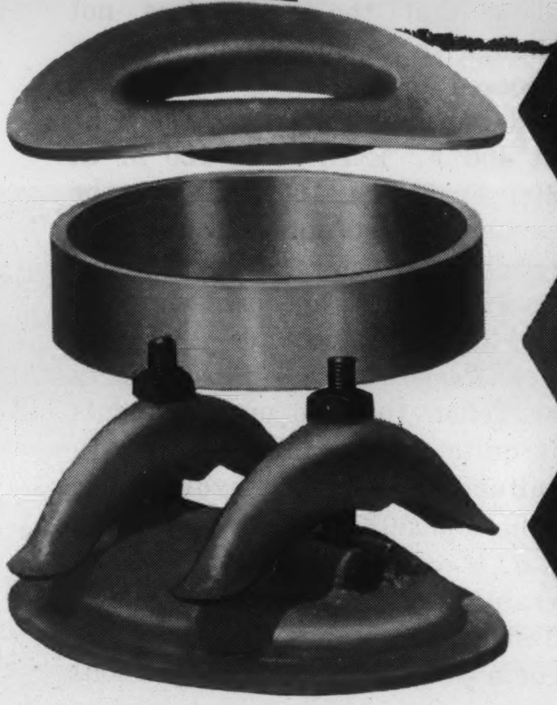

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ultraviolet radiation for 6100 hr at 140 F in an atmosphere of 50% RH has no effect on the resin.

c. Exposure to the combined action of ultraviolet rays and ozone has no effect on the resin.

Fabrication

Teflon 100X has a viscosity of about 70,000 cp in the molten state and can be processed by conventional plastics equipment at rates of 600 fpm in some instances. Since the resin has a high capacity for being drawn in the molten state, the cross section of a Teflon 100X part can be reduced 100 to 1 without leaving residual strains.

Conventional extruders with barrels having a length-to-diameter ratio greater than 15 to 1 are recommended for processing Teflon 100X. The barrel liner and screws in the extruder should be made of a corrosion resistant metal.

Techniques for extruding wire insulation, rod, tubing and jacketing, as well as techniques for blowing bottles and reworking the resin, are outlined below.

Wire insulation—High production of extruded Teflon 100X wire insulation can be achieved by extruding a tube having a larger internal diameter than the diameter of the wire; the tube is then drawn down to wire size with or without a vacuum system.

Jacketing—Using the same techniques as in wire insulation, jackets with thicknesses as low as 3 mils can be extruded at high rates of speed over wire braid and cables.

Tubing — Small diameter and thin-walled Teflon 100X tubing can be produced by a free extrusion technique involving drawdown of the melt as it emerges from a die annulus. Larger diameter and thicker walled tubing can be produced by conventional "forming box" techniques.

Rod—Rod may normally be extruded from Teflon 100X at a

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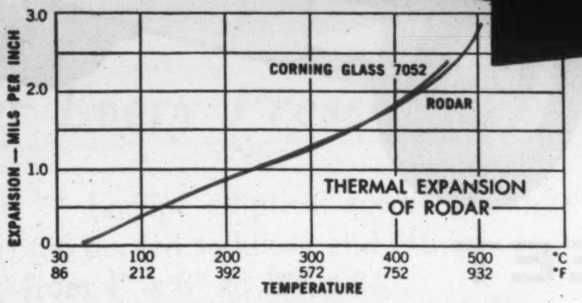

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PROPERTIES

Composition (Nominal)
Nickel 29%
Cobalt 17%
Manganese . . .30%
Iron . . . . . . Balance

Melting Point
. . 1450°C. (Approx.)

Specific Gravity . . **8.36**

Weight Per Cubic Inch
. . . . .302 lb.

Electrical Resistivity
. . . 294 Ohms C.M.F.

Tensile Strength
. . . . . . 80,000 PSI

Hardness
. . . . 82 B Rockwell

Elongation
30% (2" gauge length)

Temperature Range	Average Thermal Expansion, *Cm/Cm/°Cx10-6
30° To 200 C.	4.33 To 5.30
30° To 300 C.	4.41 To 5.17
30° To 400 C.	4.54 To 5.08
30° To 450 C.	5.03 To 5.37
30° To 500 C.	5.71 To 6.21

*As determined from cooling curves, after annealing in hydrogen for one hour at 900°C. and for 15 minutes at 1100°C.

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EFFECT OF TEMPERATURE ON TEFLON 100X[a]

Temp, F ↓	Ten Str	Elong	Yld Str
-321.......	16,000	5	16,000
-108.......	5,750	40	5,750
73.......	3,000	300	1,900
392.......	650	225	450
455.......	450	180	—

[a] Tensile and yield strengths are given in psi; elongation is given in %.

stock temperature of 630 to 670 F. The extruder should be equipped with a controlled cooling system in order to regulate rod shape and to avoid bubble formation.

Blown bottles — Teflon 100X handles very well in bottle blowing operations. In forming Teflon 100X bottles the mold should be run at temperatures of 300 to 400 F.

Rework—Teflon 100X can be reworked several times without greatly sacrificing the properties attainable with virgin material.

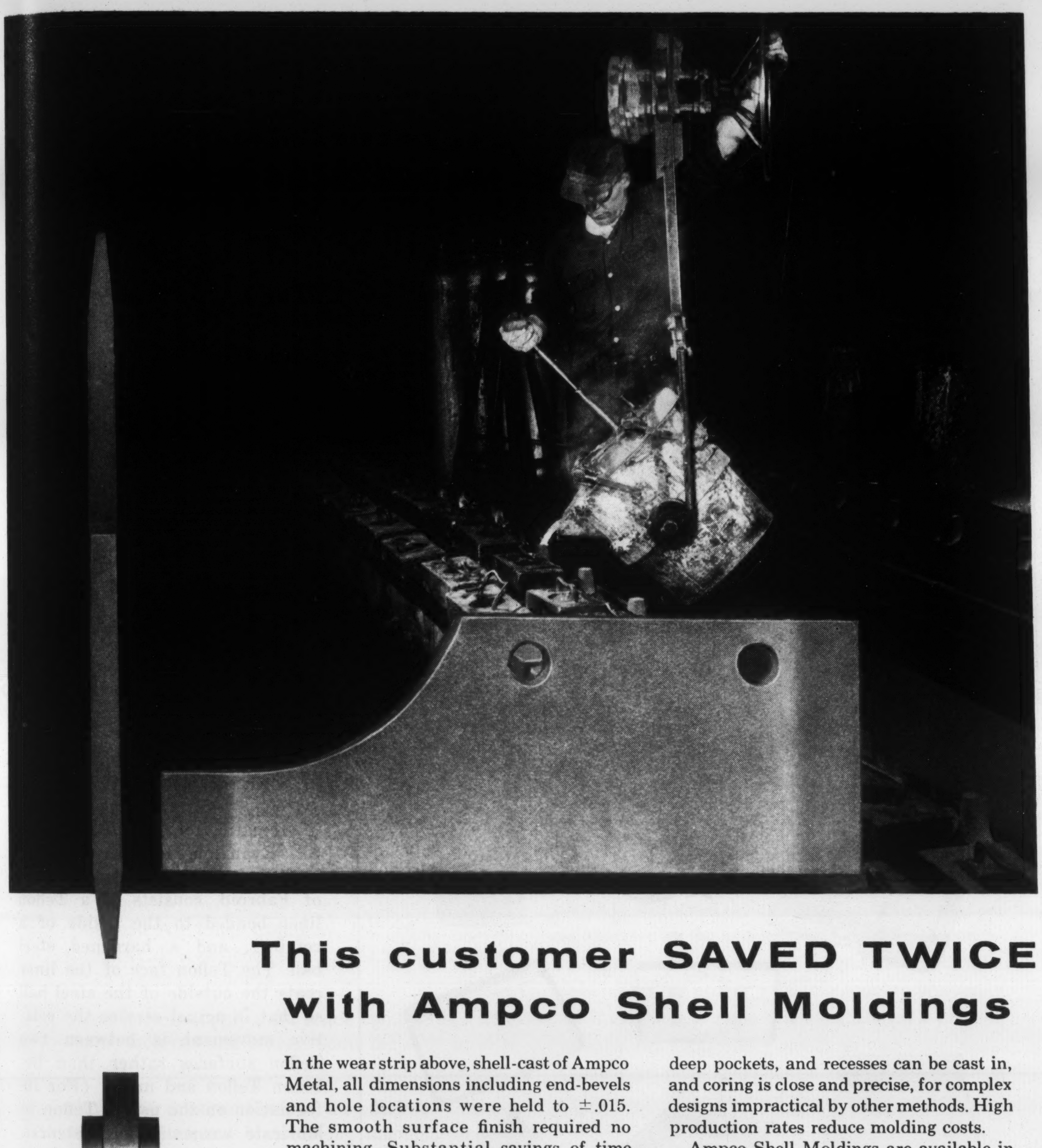
Handling — Processing equipment should be ventilated because Teflon 100X, like other Teflon resins, releases small quantities of toxic vapors at temperatures above 400 F.

This article is based on a paper presented at the 14th technical conference of the Society of Plastics Engineers, held during January in Detroit. The authors are associated with E. I. du Pont de Nemours & Co., Inc.

Cemented Carbide Is Heat Treatable

A cemented carbide, known as Ferro-Tic and produced by powder metallurgy techniques, can be annealed and quench hardened by conventional heat treating procedures. According to the producer, Sintercast Corp. of America, 134 Woodworth Ave., Yonkers 2, N. Y., the annealed carbide can be easily milled, drilled and sawed.

The producer says ". . . carbide parts requiring highly complex geometric form — for example, those with a multiplicity of holes,



This customer SAVED TWICE with Ampco Shell Moldings

In the wear strip above, shell-cast of Ampco Metal, all dimensions including end-bevels and hole locations were held to ±.015. The smooth surface finish required no machining. Substantial savings of time and money were realized.

With Ampco Shell Moldings, castings can be held to extremely favorable tolerances. Finishing operations are often eliminated; less metal is wasted. More of the tough outer cast shell is retained, providing longer service life.

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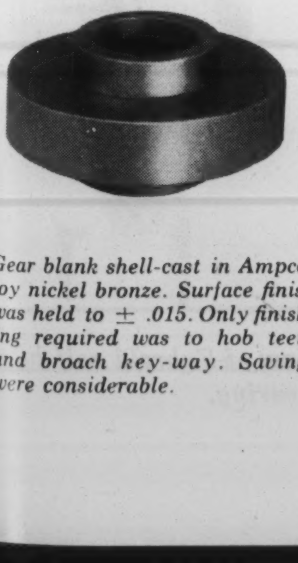
Ampco Shell Moldings are available in an extremely wide range of copper-base alloys. Ask an Ampco field engineer to tell you more about this money-saving production process. And write for Bulletin G36-957. *Ampco Metal, Inc., Dept.* MDE-4, *Milwaukee 46, Wisconsin. (West Coast Plant: Burbank, Calif.—Southwest: Garland [Dallas County], Texas).*

RM-9



Gear blank shell-cast in Ampcoloy nickel bronze. Surface finish was held to ± .015. Only finishing required was to hob teeth and broach key-way. Savings were considerable.

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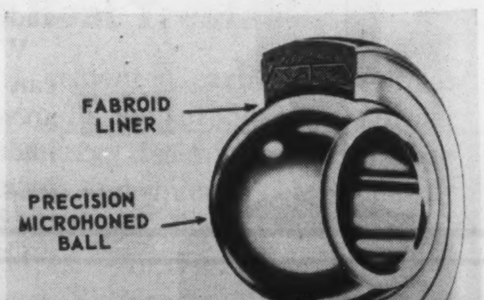
thin walls, or drastic changes in cross section—can be fabricated from Ferro-Tic at a fraction of the cost of tungsten carbide sections." The new carbide can be machined with conventional tools instead of expensive diamond and special machine tools.

Anticipated uses include drawing and forming dies, rolls, cutters, knives, guides and bearing plates. Sintercast supplies the carbide in a number of stock sizes including rounds up to 3 in. in dia and rectangular bars up to 6 in. in length.

Teflon Stops Galling in New Type of Bearing

A new type of self-lubricating ball bearing has recently been developed by Micro-Precision Div., Micromatic Hone Corp., 2205 Lee St., Evanston, Ill. The bearing, marketed under the trade name of Fabroid, consists of a Teflon liner bonded to the inside of a retainer, and a hardened steel ball. The Teflon face of the liner coats the outside of the steel ball so that in actual service the relative movement is between two Teflon surfaces rather than between Teflon and metal. (For information on the use of Teflon to lubricate weapons and fasteners,

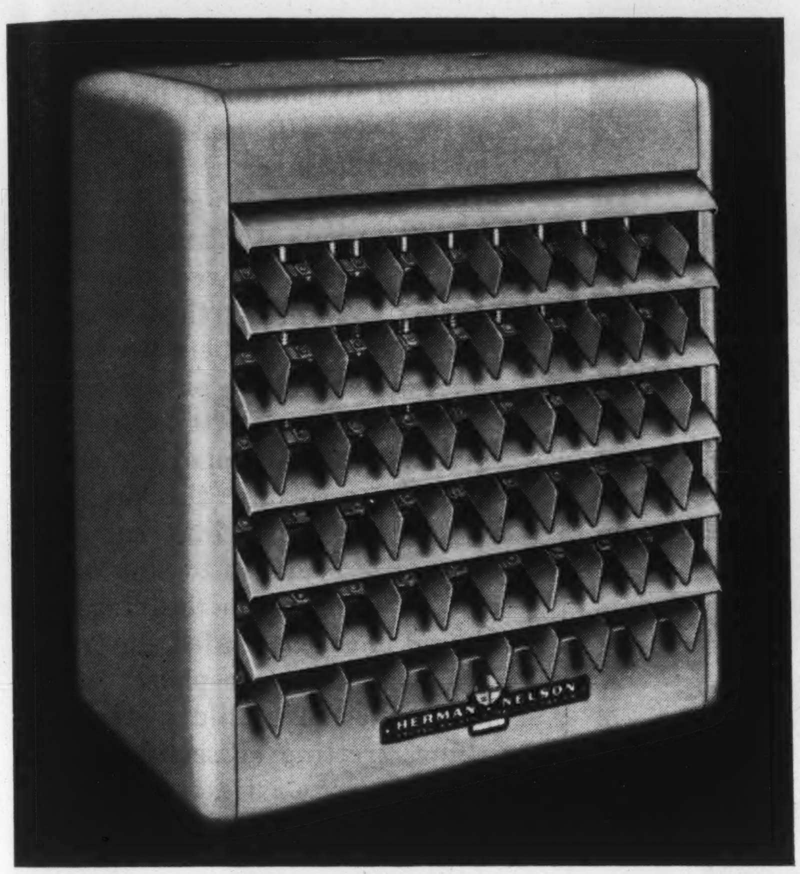


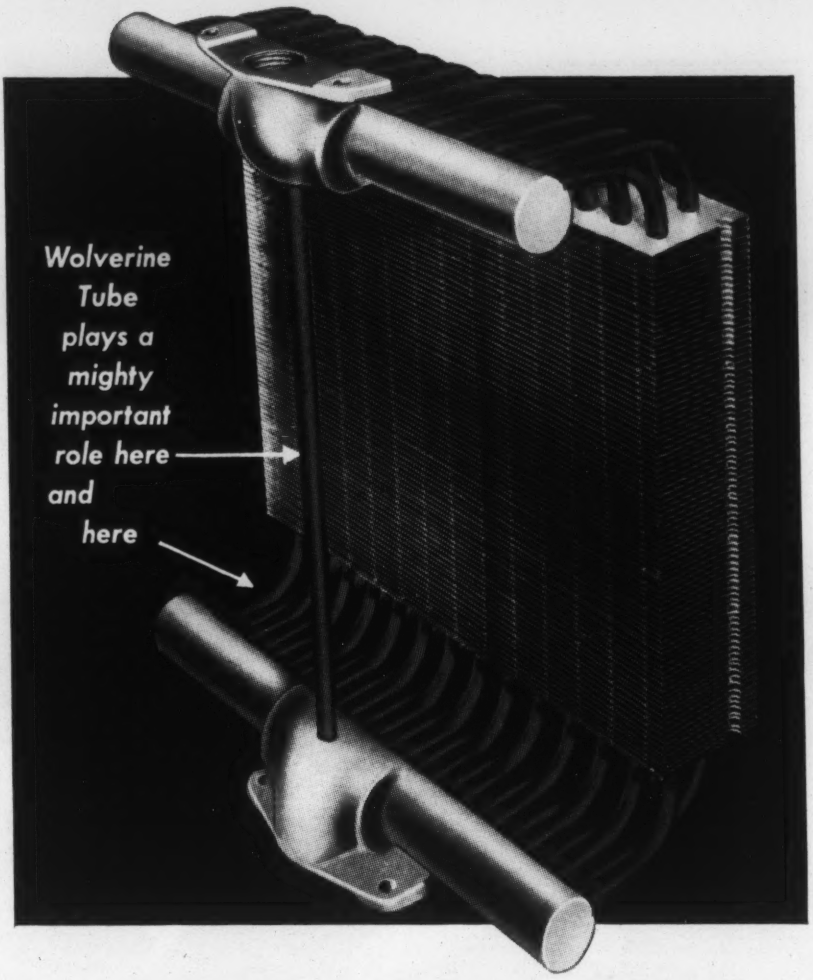
Cutaway view *of Fabroid self-lubricating ball bearing.*

ANOTHER SUCCESSFUL APPLICATION
FEATURING WOLVERINE TUBE . . .

Jack Frost is now being bossed

by HERMAN NELSON UNIT HEATERS





Wolverine Tube plays a mighty important role here and here

Illustrated here is one of many different unit heaters manufactured by Herman Nelson Division of the American Air Filter Company, Inc., of Louisville, Kentucky. It is designed to keep old Jack Frost outdoors where he belongs.

These heaters supply solid inside comfort to stores, shops, factories and offices. Some are even used in aircraft hangars!

Playing an important role in the efficiency of these units is 85-15 red brass tubing manufactured by Wolverine Tube. This tubing is used as the heating element for both condenser tubing — to which Herman Nelson applies aluminum fins—and as a patented "stay tube".

The exclusive "stay tube" is used by Herman Nelson to maintain a constant relationship between the supply and return header during the initial warm-up period . . . and because of its extra heavy wall thicknesses to withstand the attack of the corrosive gases encountered in the condensate. During the application of fins to the condenser tube and during Herman Nelson's testing program this high quality Wolverine red brass tube is expanded by 2500 psi hydraulic pressure and successfully passes air and water tests. This rugged heating element is described by Nelson engineers as "The heart of the Herman Nelson Unit Heater".

This is but another example of the many uses to which American industry puts the tubular products of Wolverine Tube. If your product uses copper or copper-base tube why not follow Herman Nelson's example—*specify Wolverine Tube*. For the complete story of Wolverine's product line write today for your copy of the General Products Catalog.

See Wolverine at Booth 1030-32 at the Design Engineering Show, Chicago, Ill., April 17-21.

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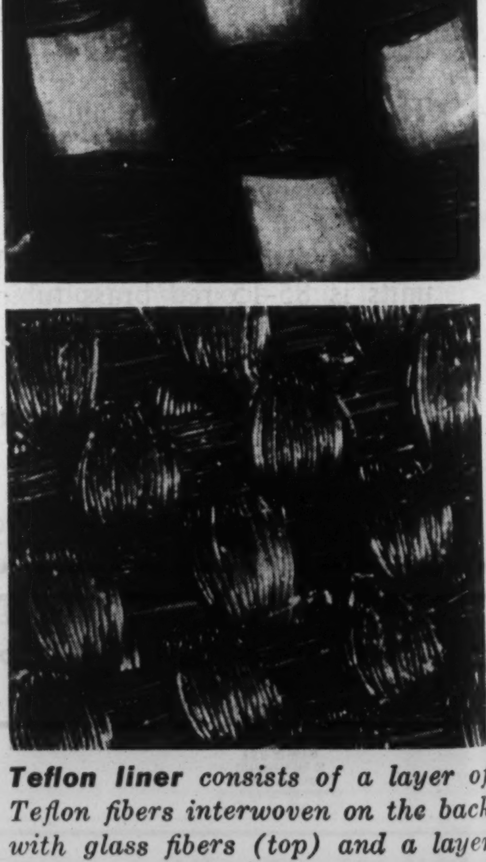
see MATERIALS IN DESIGN ENGINEERING, Aug. '57, p 147).

The liner is a composite structure consisting of two fused layers. The bearing face is a weave of Teflon fibers interwoven on the back with glass fibers, and the back-up layer is a weave of glass fibers impregnated with phenolic resins. Under load, when contact exists between the two bearing surfaces, the separate strands of Teflon fibers are locked and prevented from extruding because each strand is completely surrounded by a supporting structure. As a result, the producer says, Fabroid bearings can support static loads up to 60,000 psi.

It is claimed the bearing can be used in contaminated, dusty and abrasive-filled atmospheres without danger of failure through galling, fretting or seizing. Since the liner is elastic, contact between the two bearing surfaces



***Teflon liner** consists of a layer of Teflon fibers interwoven on the back with glass fibers (top) and a layer of glass fibers impregnated with phenolic resin (bottom).*

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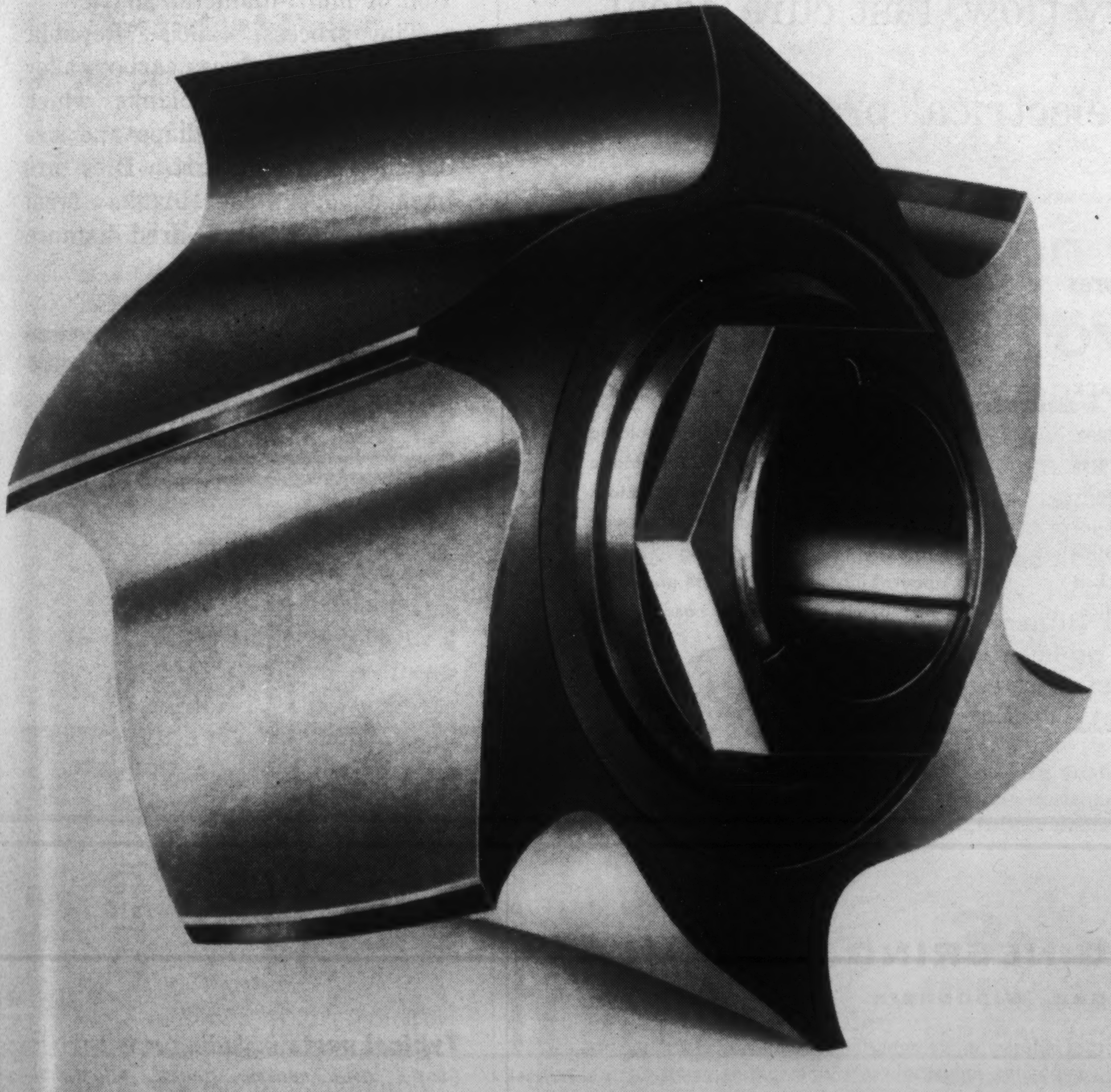

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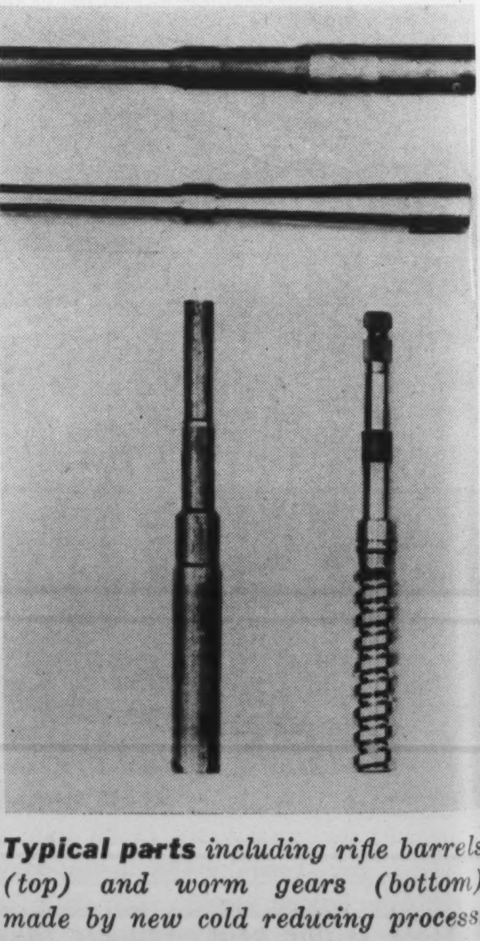
is maintained even under high dynamic loads. In addition, abrasive particles which might get into the clearance between the two bearing faces are imbedded in the relatively soft liner.

Cold Reducing Forms Strong Steel Shafts

Steel shafts for rifle barrels, automobile transmissions, electric motors, farm equipment and appliances are now being produced by a new method of cold reducing hot rolled steel bars. According to the producer, Bolt & Chain Div., Republic Steel Corp., the method affords savings of up to one ton in every three in the mass production of multi-diameter shafts.

The process, called "Republic Die-Form," produces carbon, alloy or stainless steel blanks which closely outline the shape and size of the finished part. Dies are pushed over the blanks from opposite ends to a desired distance



Typical parts *including rifle barrels (top) and worm gears (bottom) made by new cold reducing process.*

and stripped off again. The operation may be repeated on either one or both ends if further reduction is necessary. A finishing cut and/or grinding completes the operation.

According to Republic, much greater reduction is accomplished by pushing, rather than pulling as is done in cold drawing long bars. Moreover, if large reductions are attempted by cold drawing, the load required to pull the bar through the die may exceed the tensile strength of the bar and cause it to break. Republic engineers say the process holds diameters to within 0.005 in.; lengths of shoulders or step-downs are held to within 0.0625 in.

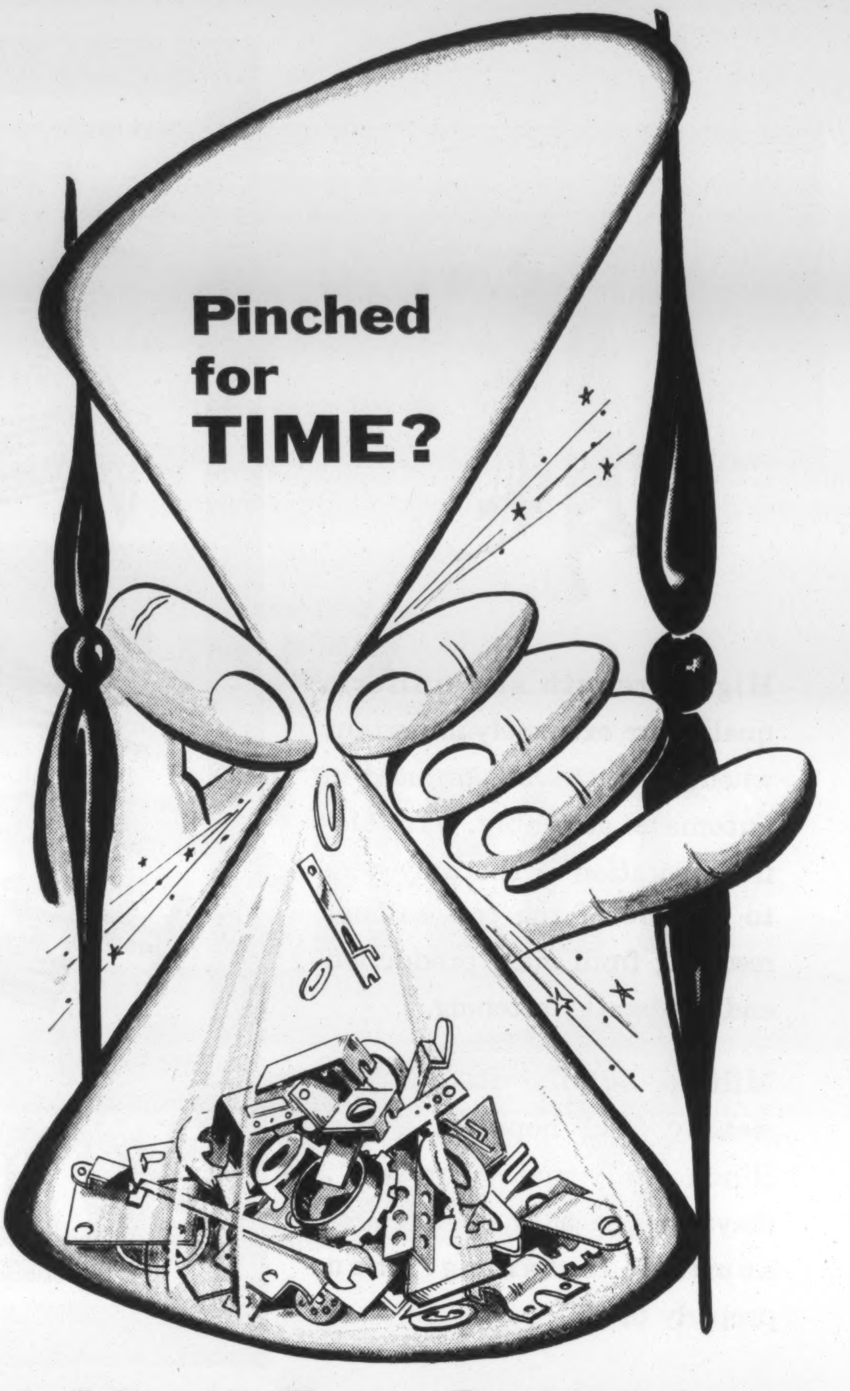
Fire Retardant Paint for Aircraft Studied

Could a fire retardant paint check the spreading flames in a burning aircraft long enough for the crew to land it safely, or at least long enough for them to bail out? Recent research at Wright Air Development Center indicates that such a paint is possible and with more research may become a reality.

The object of the research was the development of a relatively lightweight coating that could be applied like a paint over any of the metals used in aircraft construction; when subjected to excessive temperatures, the coating would foam and provide a heat barrier with sufficient insulation to protect the base metal from deleterious effects. Most of the numerous paints evaluated failed because of their poor water resistance and loss of effectiveness on aging.

Why paint is wanted

Present methods of fire control in aircraft are based on an extinguisher system in combination with steel fire walls. The weight



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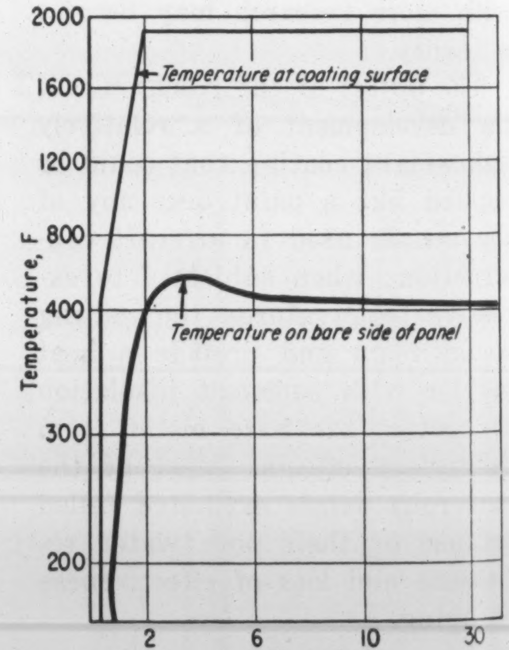
involved requires that such fire control systems be held to an absolute minimum. A workable fire retardant paint could conceivably eliminate this system and provide a better heat barrier than present steel fire walls. Also, it could conceivably reduce aircraft losses; 80% of the aircraft losses of World War II were due to fire.

Details of the research project, prepared by the personnel of the Protective Processes Branch of Wright Air Development Center with S. Collis acting as project engineer, appear in Report No. PB 131002 issued by the Office of Technical Services, U. S. Dept. of Commerce, Washington, D. C.

How it should perform

Mr. Collis and his staff first set up a number of requirements the paint should meet:

1. *Insulating properties*—The paint, when subjected to a flame temperature of 2000 F for 30 min, should provide sufficient insulation to keep the temperature of the base metal at not more than 350 F. It should provide this insulation even on a vertical, vibrating surface, which is en-



Insulation characteristics *of a fire retardant paint containing boric oxide, lead carbonate and silicone resin.*

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countered in normal aircraft operation.

2. *Adhesion*—The paint should adhere well to aluminum alloys, clad aluminum, magnesium and steel.

3. *Weight*—The weight of the paint should not exceed 12 lb per 100 sq ft.

4. *Application* — It should be easy to apply the paint by brush or spray methods.

5. *Flexibility*—The paint should have satisfactory flexibility both at normal and low temperatures.

6. *Water, solvent resistance*—The paint should not be adversely affected by 24 hr immersion in water; 4 hr immersion in aromatic fuel; or 168 hr immersion in lubricating oil.

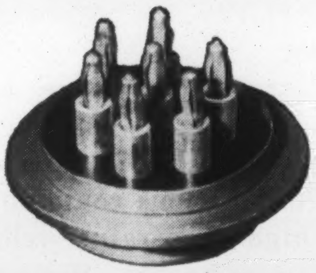
Whether any given material will meet the above requirements can be predicted with a fair degree of accuracy, according to Mr. Collis. However, foaming characteristics of the materials are relatively unknown and their determination is dependent to a considerable degree upon trial and error. Three basic steps must be achieved in progressive order to produce a satisfactory foaming reaction:

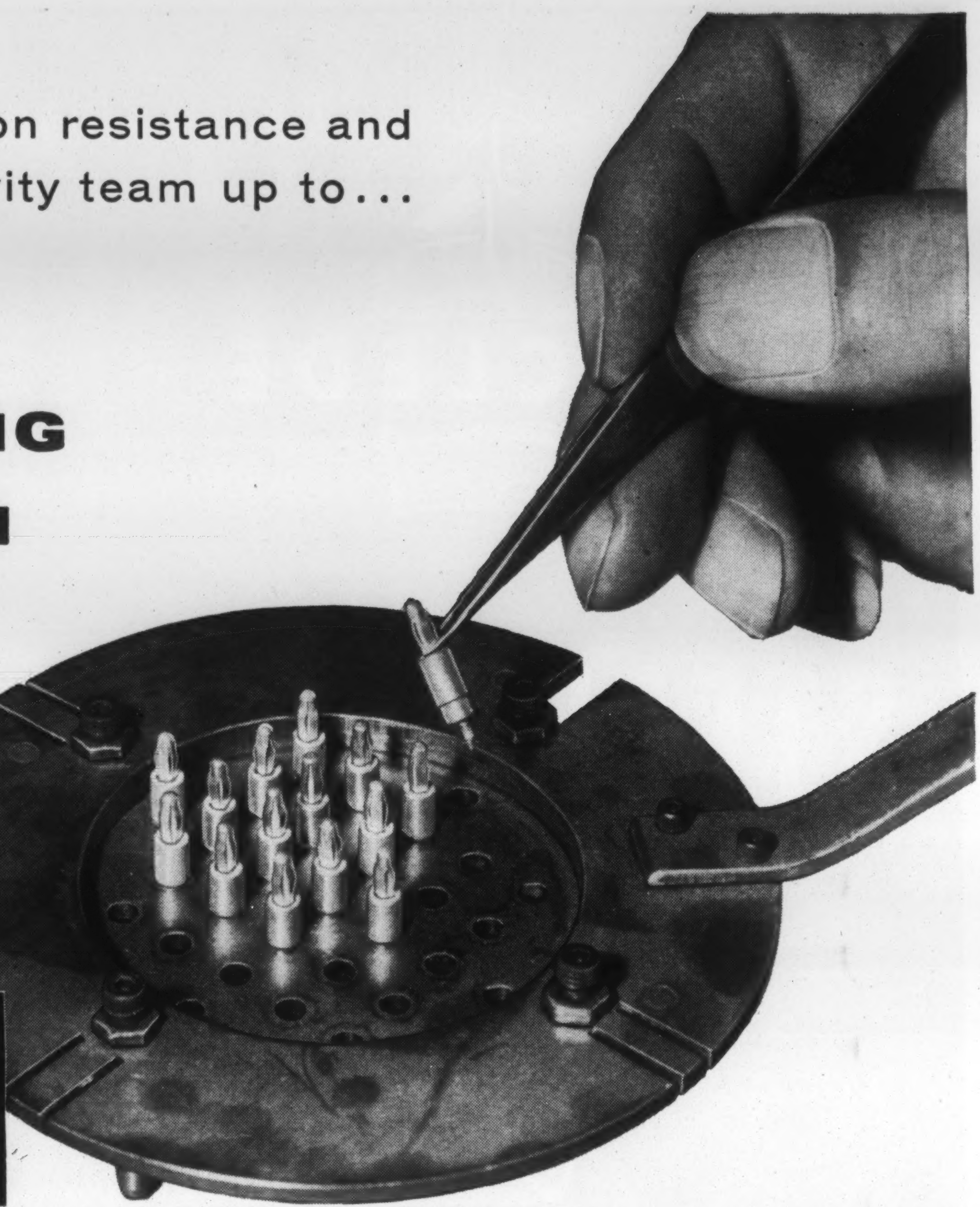
1. The paint should soften and become plastic at or below the foaming temperature so that it can foam.
2. A blowing agent should provide a volume of gas quickly enough to form a fine textured foam.
3. The foam should "freeze" in place as soon as it reaches its maximum volume.

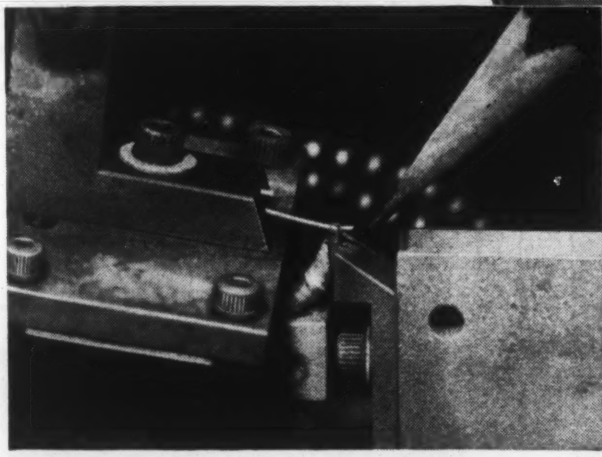
The progress so far

Having set up the requirements, Mr. Collis and his staff set out to find the best combination of binders, fillers and blowing agents that, when combined into a paint, would provide a suitable fire retardant coating. Although no one combination of binders, fillers and blowing agents is suitable as yet, Titanium's corrosion resistance and low heat conductivity team up to...

DOUBLE SOLDERING PRODUCTION







All-titanium *dip soldering jig developed and used by Astatic Corporation has advantage of low heat conductivity and corrosion resistance.*

Titanium *jig has excellent wear resistance, permits holding close tolerances when soldering phonograph needle assembly.*

In handling a variety of soldering operations on small precision parts, Astatic Corporation—electronics manufacturer—has realized many benefits with Mallory-Sharon commercially pure titanium soldering fixtures:

- Corrosion resistance of the titanium fixtures to certain soldering fluxes is excellent. Thus service life is far longer than that of other metals previously used.
- Heat conductivity of titanium is low. Thus the fixture does not take heat away from the work, and the operation takes less time. On a typical assembly, use of the titanium fixture increased daily output from 1000 to 2500 parts per day.
- Titanium's excellent wear resistance, plus the fact that solder does not stick to titanium, allows very close tolerances to be maintained. Assembly rejects were cut from 25% to less than 1%.

Can *you* use titanium's unique advantages? For information on properties and fabrication techniques ask for the booklet "Titanium Fact File". Write Mallory-Sharon Metals Corporation, Niles, Ohio. Mallory-Sharon produces titanium, zirconium, and other special metals in sheet, strip, rod, bar, plate and other standard shapes to meet your requirements.

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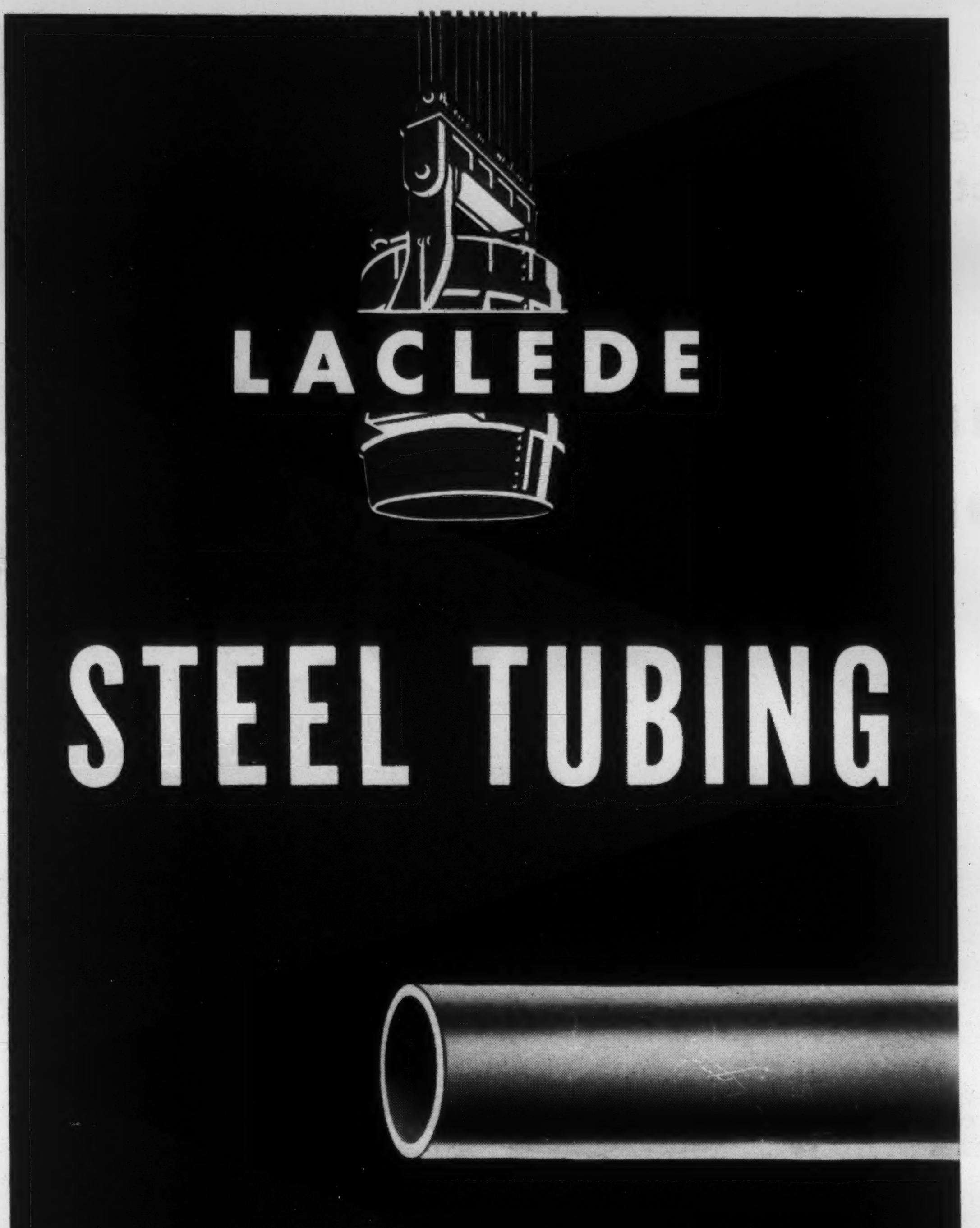

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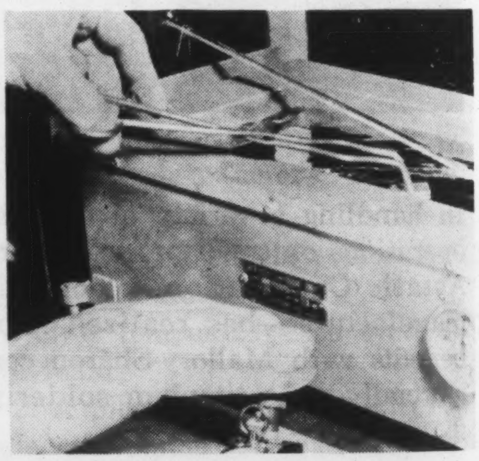
some useful information has been developed:

Binders and vehicles — Boric acid, borax and other low temperature glass forming materials appear to offer very good possibilities for use in the top coat of a multi-coat system. Thermosetting resins such as silicone, epoxy and possibly phenolic offer good possibilities as both binders and vehicles for the foaming reaction.

Fillers — A mixture of equal parts of magnesium silicate and starch seems to be a good filler for formulations containing glass as a high temperature vehicle.

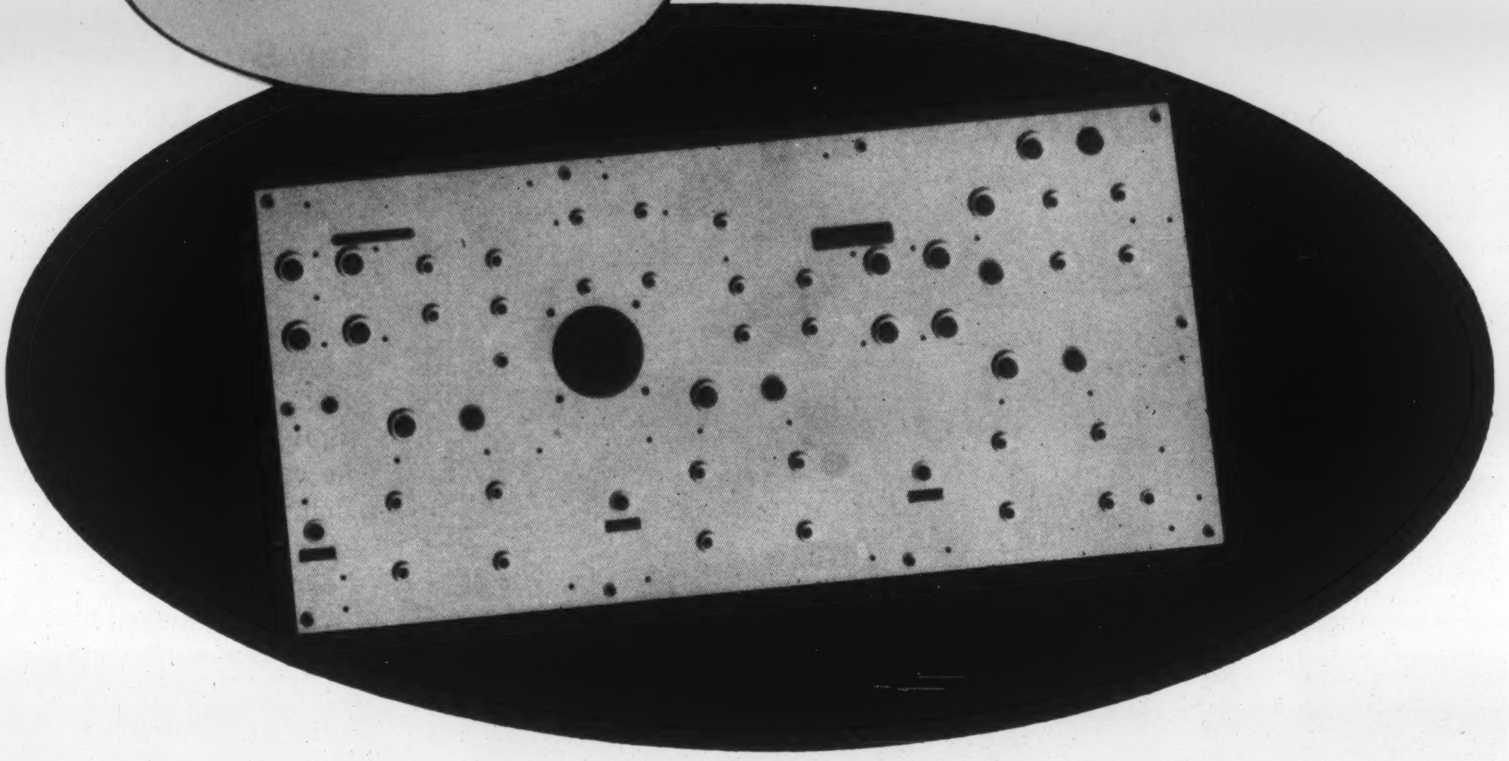
Blowing agents—Boric acid and metal carbonates seem to be good blowing agents for the paints. Metal carbonates offer a means of solidifying the foamed glasses by the reaction of the oxide decomposition product with the glass.

(more What's New on p 192)



Hot laminate — Sample of a new copper clad glass-epoxy laminate is dipped into a solder pot at 500 F without any harmful effects taking place. The laminate, called Textolite 11558 and available from General Electric Co., Laminated Products Dept., Coshocton, Ohio, is characterized by a copper-to-laminate bond that is said to be as resistant to cyanide plating solutions, solvents and thermal aging as the base laminate itself. According to the producer, the laminate will easily pass any existing dip solder specification.

Spauldite G5-766



Maintains high arc resistance at 300°F operating temperatures

Spaulding's G5-766 Glass Melamine Spauldite provides the properties needed for applications requiring high arc resistance, mechanical strength, hardness and fine machining. Spauldite is recommended for switch and circuit breaker insulation, as well as for applications where severe mechanical stresses are encountered.

SPAULDITE G5-766

PROPERTIES		CONDITION	⅛" THICK
Arc Resistance		D-48/50	183 sec.
Dielectric Breakdown			
Parallel to plies		A	over 50 KV
Step by step		D-48/50	over 50 KV
Dielectric Strength			
Perpendicular to plies		A	
Short time			over 400 V/M
Step by step			over 400 V/M
Water Absorption			.48%
Specific Gravity			1.95
Flex. Strength PSI	WG	A	57,000
	AG		49,000
Izod Impact Ft. Lbs./In.	WG	E-48/50	10.8
	AG		8.6

Spauldite G5-766 is available in sheets, rods, tubes and fabricated parts.
For more information, contact:

SPAULDING FIBRE COMPANY, INC.
312 Wheeler Street Tonawanda, New York
28 Offices in Principal Cities

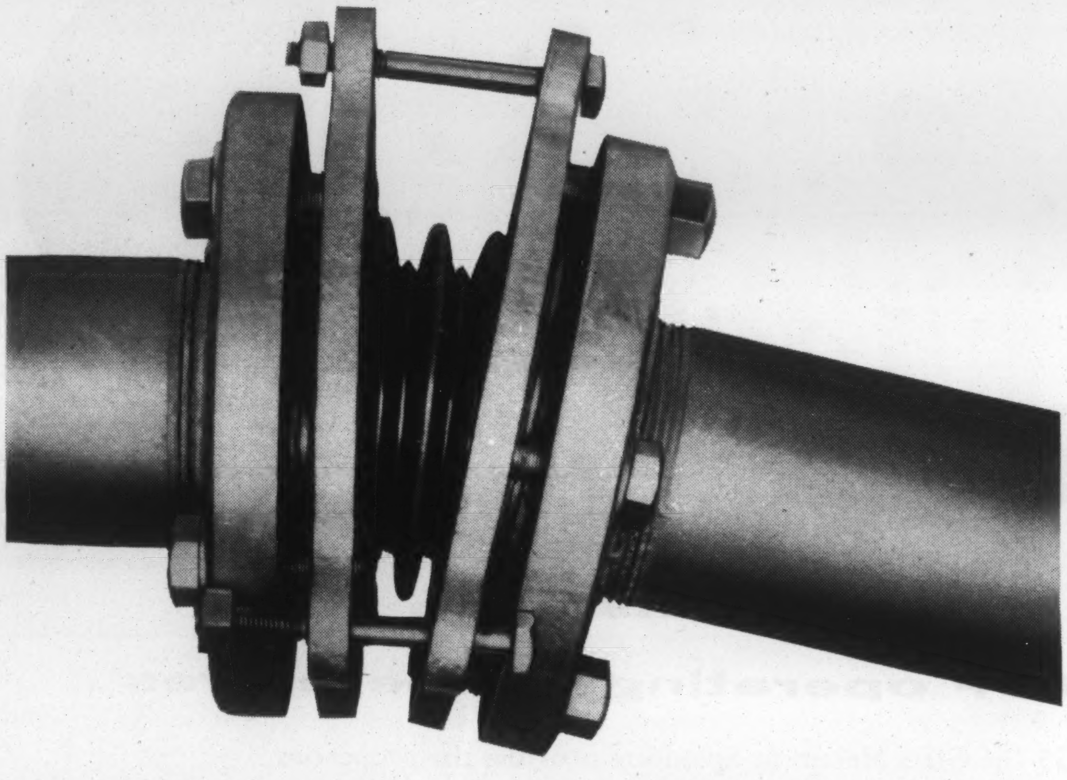
Visit Spaulding at the (Design Engineering Show Booth 565)

For more information, turn to Reader Service card, circle No. 433

Fluoroflex®-T Molded Bellows

LAST FAR LONGER

because they're made of TEFLON® at its best



Molded, not machined, for continuous, undamaged grain

Special compound developed for maximum flex life

High density, non-porous

Chemically inert, universally useful, non-contaminating

BELLOWS MOLDED OF FLUOROFLEX-T offer at least 20 times the flex life and twice the burst strength (after flexing) of ordinary bellows machined from Teflon. At long last, you have chemically inert flex joints with predictable service life, even under extreme conditions.

FORGET ABOUT SUDDEN FAILURES — COSTLY DOWNTIME. One big user severely flexed Fluoroflex-T bellows 20,000,000 times...abandoned the test without a failure.

Even at *400°F.*, tested through *maximum* expansion range under full *dynamic* working pressure . . . bellows went through 100,000 cycles before tests were discontinued . . . still without failures.

NEW BULLETIN TELLS MORE — gives operating and construction data. Write RESISTOFLEX CORPORATION, Roseland, New Jersey. Southwestern Plant, Dallas, Tex. Western Plant, Burbank, Calif.

® Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
® Teflon is DuPont's trademark for TFE fluorocarbon resins

Make it a point to see Resistoflex products at the Design Show.

RESISTOFLEX

For more information, turn to Reader Service card, circle No. 449

Bar Stock Available in Alloy 2011-T3

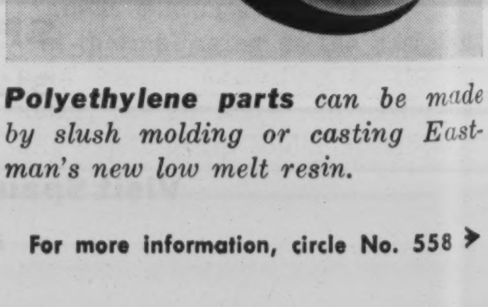
Harvey Aluminum Co., 19200 S. Western Ave., Torrance, Calif., is now offering hollow aluminum bar stock in alloy 2011-T3. The wrought aluminum alloy is said to be especially useful in such high speed operations as threading, tapping and screw machine work. The company says ". . . excellent machined finishes at a low rate of tool wear are possible with use of the alloy."

A semi-finished product, the hollow bar stock is said to offer faster machining speeds than conventional aluminum bar stock because no time is required to rough out a cavity. The hollow stock is available in round and hexagonal shapes in a range of sizes to fit any machining job.

Polyethylene Resin Has Low Melting Point

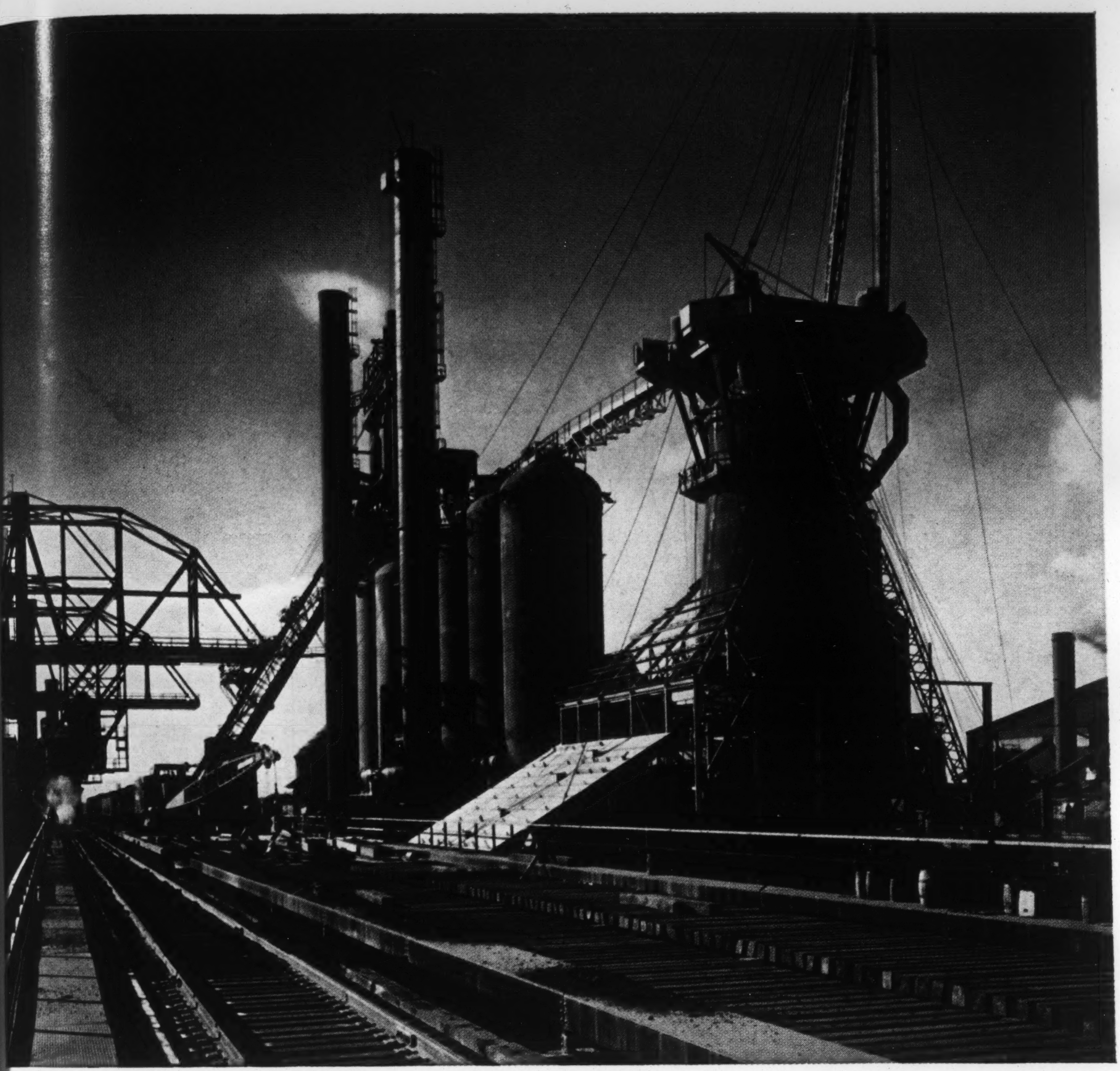
Eastman Chemical Products, Inc., Kingsport, Tenn., has introduced Epolene C, a low melt polyethylene resin that is said to have properties similar to conventional polyethylene resins, yet can be handled much like a moderate to high melting wax. Three general areas of use are foreseen for the resin:

1. *Melt casting*—It can be used



Polyethylene parts *can be made by slush molding or casting Eastman's new low melt resin.*

For more information, circle No. 558 ➤



Under construction—Trenton, Michigan, Plant

McLouth Blast Furnace No. 2

The second major expansion in four years is nearing completion at McLouth Steel.

We are again adding to our facilities to bring you better steels for the product you make today . . . and the product you plan for tomorrow.

McLOUTH STEEL CORPORATION

Detroit 17, Michigan

Manufacturers of high quality stainless and carbon steels.

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EXACTLY
as
shipped!

ORBITS
O—3
N—18
M—18
L—8
K—2
49
$^2P^\circ_{1/2}$
In
$5s^2\,5p^1$
indium
$\tau^l = 2{,}4$
117 116 115
114.76
116
113 112 111 110

- AIDS LUBRICATION
- UNIQUE STABILIZATION
- ALLOYS READILY

INDIUM

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at the Indium Corporation of America means purity of metals, and strict adherence to specifications.

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...and shipped *exactly* as specified — that's our pledge to you. For instance, Indium Corporation spheres and pellets are carefully placed in containers, then sealed into a transparent, plastic, tamper-proof wrapper. Inside each wrapper, is a printed tag reading "IF THIS PACKAGE HAS BEEN OPENED IN TRANSIT, WE DO NOT GUARANTEE THE PRODUCT."

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Since 1934 . . . Pioneers in the Development and Applications of Indium for Industry.

For more information, turn to Reader Service card, circle No. 369

with or without the addition of coloring agents to form relatively hard, tough, cast and slush molded objects.

2. Hot dip—Its application as a protective coating to a variety of products is being investigated.

3. Hot melt—It can be applied to practically all types of paper. According to the producer, a complete bond forms between Epolene C and paper because the melt penetrates right into the paper.

Galvanized Wire

An extra bright galvanized wire, available in a variety of ASWG sizes up to 20 gage, is being marketed by Sambre-Escaut Div., S. A. Cockerill Co., Ougree, Belgium. The Belgium company's commercial outlet in this country is M. Paquet & Co., 17 Battery Place, New York 4.

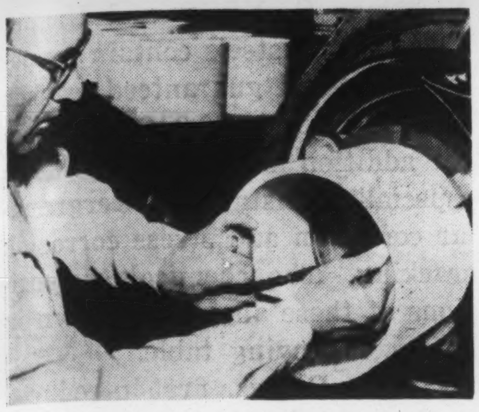
Pure Alumina Ceramic Has High Strength

A new, nonporous, 99% aluminum oxide ceramic has been developed by Coors Porcelain Co., 770 Ninth St., Golden, Colo. A variety of parts made from the ceramic are now available in production lot quantities from the company.

Called AD-99, the ceramic has a tensile strength of 34,000 psi—said to be some 30% higher than the strength of the best commercial aluminum oxide ceramic. In addition to high strength at room temperature, the ceramic is said to retain 75% of its tensile strength at 2000 F.

Coors AD-99 has good electrical properties. Dielectric loss characteristics of the material at various microwave frequencies are said to be lower than those of most plastics and lower than those of all

For more information, circle No. 559 ›



Large part *made of Coor's new ceramic will be used as a vacuum tube envelope.*

but one or two special ceramic materials. For instance, the loss tangent at room temperature is 0.00006 to 0.00002 at 100 mc and less than 0.0001 at 300 mc.

According to the producer, the ceramic has high hardness and good wear resistance. It is completely homogenous, has an extremely fine crystal structure, and has a high density. It can be fired economically at practical temperatures.

Already used to make large radomes, the ceramic is now being made into vacuum tube envelopes measuring 10 in. in dia and 8½ in. in height (see photo). Other uses include high temperature bearings and gage blocks.

Corrosion Resistance of Four French Steels

During the last 20 years or so the French steel industry has introduced several stainless steels that differ appreciably from those commonly produced in the U. S. Noteworthy among these steels are those with molybdenum contents ranging from 2.5 to 6%.

Information on the corrosion resistance of these steels was given recently by L. Colombier and J. Hochmann before meetings of industrial chemists in France. The steels discussed by Colombier and Hochmann are Uranus B 6,

Shown 1/16 actual size

HACKNEY shapes meet needs of a changing world

Missiles! Moons! Rockets! Old, familiar words that mean new, unfamiliar problems for design and production engineers.

They are challenging words, too, to our engineers who are called upon to apply the *Hackney Method*—deep drawing shapes and shells from cold metals—to provide practical, economical answers to Space Age engineering problems.

The photo above shows how *Hackney Methods,* familiar for many years to engineers in many industries, can produce deep drawn, seamless parts for missiles which have maximum strength with minimum weight.

For detailed information about *Hackney Methods,* and their application to your design and production problems, write:

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For more information, turn to Reader Service card, circle No. 581

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Find out fast who's exhibiting what and where

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IN BOOTH 801

INFORMATION CENTER

The *Information Center* is designed to put you in immediate touch with all exhibitors that make products of particular interest to you, especially when:

- you have only limited time, and must budget it carefully.
- you have toured the show and can't find some product you are anxious to see.
- products of importance to you are not on display (the *Information Center* can tell you if one or more exhibitors make these products, and have information on them available).

Over 400 exhibiting companies have supplied the information about their products which makes the *Information Center* possible, and we are glad to provide this service to you again this year.

This is a repeat of the Information Center which helped many hundreds of visitors get the most out of last year's Design Engineering Show.

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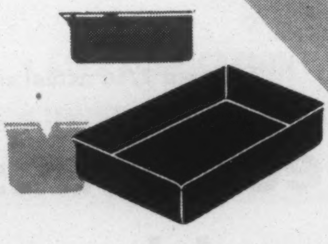

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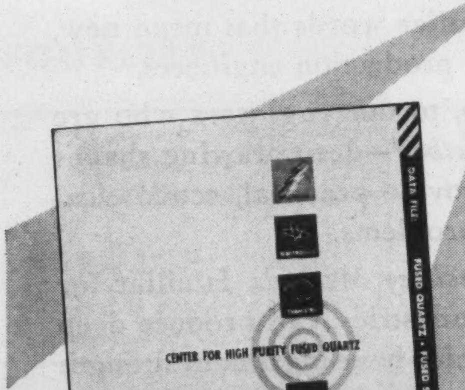
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What's new IN MATERIALS

Nicromaz C, NSCD and Uranus 50. All four steels contain copper and have a guaranteed carbon content of under 0.04%, the copper addition is said to make them especially resistant to intergranular corrosion and stress corrosion cracking. The chemical compositions of these alloys are shown in an accompanying table.

Uranus B 6 was first introduced in France in 1933 and is still fabricated as it was originally, except that it is now vacuum processed to produce a low carbon content (0.03%). It is available in forgings, bars, sheets and various shapes.

According to Colombier, Uranus B 6 has excellent corrosion resistance to either concentrated or dilute sulfuric acid at temperatures up to 120 F. In 25% sulfuric acid, which is the limit of corrosion resistance for type 317 stainless steel at room temperature, Uranus B 6 can be used at temperatures up to 195 F. In addition to sulfuric acid, Uranus B 6 has good corrosion resistance to dilute hydrofluoric acid; boiling phosphoric acid; sulfurous acid; and cupric, ferric and tin chlorides.

Nicromaz C is similar in composition to Uranus B 6 except for a difference in molybdenum content: 5% instead of 4.5%. Like Uranus B 6, it has good corrosion resistance in most organic and inorganic acids and salt solutions.

Uranus 50 has been in commercial production for over 20 years and is particularly recommended for use with sulfuric acid. Hochmann says the presence of copper

CHEMICAL COMPOSITION OF FRENCH STAINLESS STEELS (%)

	Cr	Ni	Cu	Mo
Nicromaz C.......	20.0	25.0	1.5	5.0
NSCD..........	18.0	16.0	3.0	6.0
Uranus 50........	20.0	8.0	1.5	2.5
Uranus B6.......	20.0	25.0	1.5	4.5

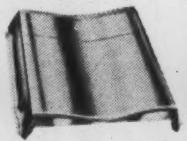
For more information, circle No. 507 ➤

Swedlow specializes in heat protection!

Phenolics
Epoxies
Reflective coatings
Sheet materials
Molded parts
High temperature welded honeycomb core

The solution to your heat problem is in the following...

Swedlow's aluminum-metallized heat reflective laminates 1650°F



MINIMUM WEIGHT • MINIMUM BULK—By combining the principles of highly efficient reflectivity of aluminum-metallized surfaces with the low thermal conductivity of glass fabric reinforced plastic laminates, Swedlow's "—101" metallized coatings offer protection up to 1650° F. The metallic coating protects the base laminate from thermal degradation.

APPLICATIONS—In flat sheets, or molded into complex contours, these materials are suggested as highly efficient heat blankets for compartment insulation, valve protection, exhaust heat damping, and other applications where there is prolonged high temperature exposure.

Swedlow's silicone plastic laminates 650°F

Swedlow's X5G-138 and X5G-176 silicone base materials are available as flat sheeting or molded parts and offer protection up to 650°F.

Swedlow's X5G-138 provides maximum strength per unit of thickness and weight and is recommended for applications requiring flat sheets or simple contoured molded parts.

The X5G-176 laminate has slightly lower physical properties than X5G-138 but is recommended for applications requiring complex contours.

APPLICATIONS—Missile nose cones, exit cones, fins, stabilizers, adapter rings, closure rings, and similar uses. Applications in airstreams at missile speeds are possible.

Swedlow's high temperature welded honeycomb core /2500°F / 2000°F

HIGH STRENGTH-WEIGHT RATIO • HIGH RIGIDITY-WEIGHT RATIO • HIGH VIBRATION DAMPING • HIGH FATIGUE RESISTANCE—The use of high temperature honeycomb core is expanding rapidly in a wide variety of aircraft and missile assemblies and parts, particularly where such parts experience high engine temperatures, aerodynamic heating, and corrosive environments. On your production line, use of honeycomb core assemblies reduces the number of parts, simplifies fabrication and assembly, reduces tooling, floor space and over-all costs per pound, and cuts repair and rework. Face sheets may be brazed to the core by the user for use at temperatures approximating 2000° F., or adhesives may be used if temperatures do not exeed 500°F.

APPLICATIONS—Wherever structural strength and corrosion resistance are required at extreme temperatures...with light weight.

600°F *Swedlow's high temperature phenolic plastic laminates*

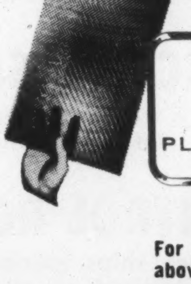
STABLE PHYSICAL PROPERTIES UNDER HIGH TEMPERATURES—Swedlow's X4G-116 is a high-temperature phenolic laminate that offers unusual physical stability at high temperatures up to 600°F. It is available in flat sheets, and can be molded to complex contours.

APPLICATIONS—Fins, stabilizers, missile nose cones, adapter rings, closure rings, and similar applications. May be used in airstreams at missile speeds.

450°F *Swedlow's epoxy-plastic laminate*

Swedlow's X6G-141 epoxy-plastic laminate gives the user an electrical insulating material resistant to fracture and warpage in installation, with characteristics of very low moisture absorption and high physical strengths over a prolonged temperature gradient. Approved under MIL-P-18177. Conforms to NEMA standards for type G-3 materials.

APPLICATIONS—Air conditioning and heat distribution ducts. Winding barriers and ducting in transformers. Sheeting for circuitry installations. Dielectric capacitors for condensers. Terminal board and strip applications in electronic equipment. Coil spacers and relay bases in magnetic devices. Mounting plates, contact spacers and shielding for control devices.



Swedlow
PLASTICS COMPANY

Los Angeles, California
Youngstown, Ohio
Please refer to Dept 18

For short duration of time the temperatures given for the above materials may be raised appreciably. Each application must be considered individually.

Swedlow is continuing research in high-temperature materials of all types . . . reflective coatings, ceramics, plastics, metals.

A highly trained staff of engineers and technicians will be pleased to assist you on the use of these materials for high temperature service. Please contact the plant nearest you.

heat problems?

in this steel greatly enhances its resistance to corrosive media. He says, ". . . much is unknown about the action of copper in stainless steel but it is a very powerful aid in reducing the corrosive action of sulfuric acid. It is in solid solution in the alloy and does not leach out into media where stainless steels are used."

Uranus 50 has good resistance to intergranular corrosion and to stress cracking. It also has good resistance to hot sulfurous acid under pressure; to hot phosphoric acid and salt solutions; and to boiling acetic, formic, tartaric and citric acids.

NSCD has corrosion resistance properties quite similar to those of Nicromaz C. Its lower nickel content (16%) is balanced by a higher content of molybdenum (6%) and copper (3%).

Cellulose-Base Finishes Fused onto Metal Parts

Heavy cellulosic coatings from 8 to 15 mils thick can now be applied to castings, stampings and wire in a single dip by using a new powdered resin specially formulated for a fluidized coating process called Whirlclad. Developed by National Polymer Products, Inc., 125 North 4th St., Reading, Pa., the cellulosic finish, called Corvel, joins a family of powdered nylon, polyethylene and chlorinated polyether resins specially formulated for fluidizing.

According to the producer, Corvel cellulosic powders of various colors can be applied to provide a surface of controlled sheen from

SOURCES of most engineering materials can be found in M/DE's "Materials Selector" reference issue, published last September. Properties of all materials are also given.

DON'T OVERLOOK
CARBON-GRAPHITE!

Considered from performance, cost or availability standpoints, even many of the newest "wonder" materials are poor substitutes for carbon and graphite in numerous instances. Whether your application involves such problems as friction, elevated temperatures, commutation, arcing, or shaft sealing, chances are Stackpole Carbon, Graphite or composite Carbon-Graphite-Metal Powder materials can fill the bill better—at less cost.

BEARINGS
Self-lubricating units molded to desired shapes and close tolerances. High temperature types.

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Special pump and shaft seals for oils, air, gases, corrosive chemicals and other liquids.

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Critical control for voltage, line, speed and pressure regulators, continuously adjustable rheostats, etc.

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Close tolerance types for foundry work, powder metallurgy, etc.

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Withstand temperatures to 1000° F. Wear well against steel.

CORROSION CONTROL RODS
Positive protection for pipe lines, ships, marine structures and other buried or immersed metal objects.

POROUS CARBON
Electrically conductive—inert—stable at high temperatures.

PUMP VANES
Corrosion-proof, self-lubricating. For air, chemical or gas pumps.

BRAZING BOATS & FIXTURES
Withstand extreme thermal shock — permit quick cooling. Alloys do not stick to them.

CONTACTS
Ideal where metal contacts fail from arcing, welding, etc.

CHEMICAL ANODES
Long-life types reduce clogging, cut cell maintenance costs.

Also BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • SALT BATH RECTIFICATION RODS • DASH POT PLUNGERS • HEATING ELEMENTS • WELDING CARBONS • RESISTANCE WELDING & BRAZING TIPS . . . and dozens of other specialties.

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"Everything in Carbon but Diamonds"

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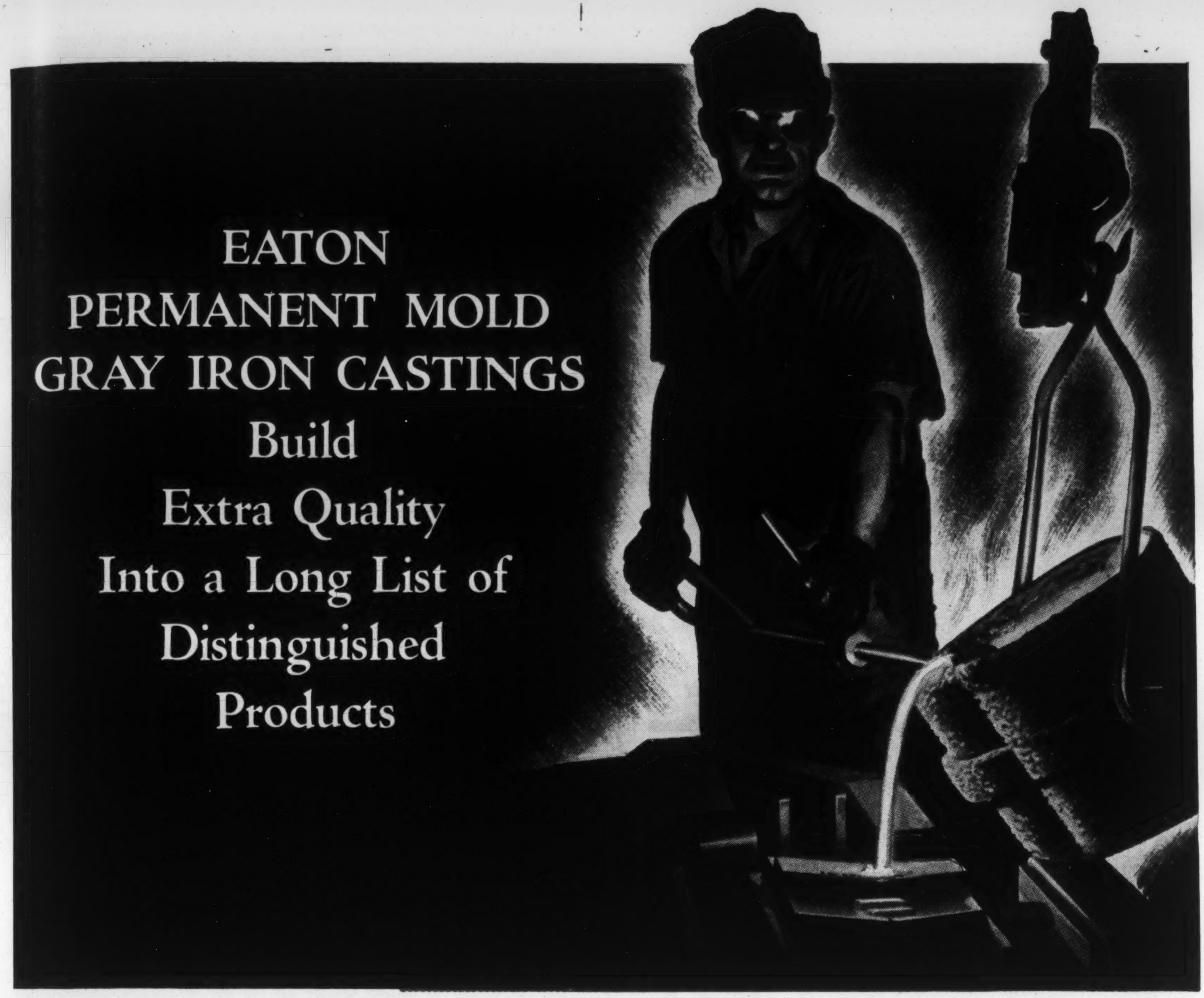

Leading manufacturers in practically every major industry have found that the superior structure of Eaton Permanent Mold Gray Iron Castings contribute many worthwhile benefits, not only in the ultimate quality of the finished product, but in manufacturing economies. This is especially true in such fields as motor cars and trucks, refrigeration, air conditioning, domestic appliances, and hydraulic equipment—wherever a dense, non-porous, leakproof structure is a critical requirement. Eaton's advanced production methods, combined with the latest in foundry facilities, assure uniformly high quality and the capacity to deliver on schedule.

Engineers of the Eaton Foundry Division have assisted many of our customers in casting design and process development. Whatever your requirements, our engineers will be pleased to work with you. Why not discuss the advantages of Eaton Permanent Mold Gray Iron Castings applied to your product? Just write or phone—there's no obligation.

Check these Important Advantages:

★ **Dense, non-porous, homogeneous structure**
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★ **Excellent tensile strength**
★ **Ability to take a high surface finish**
★ **Freedom from leakage under pressure**
★ **Intricately cored sections**
★ **Uniformity of castings**
★ **Higher machining feeds and speeds**
★ **Substantially increased tool life**

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VASSAR, MICHIGAN

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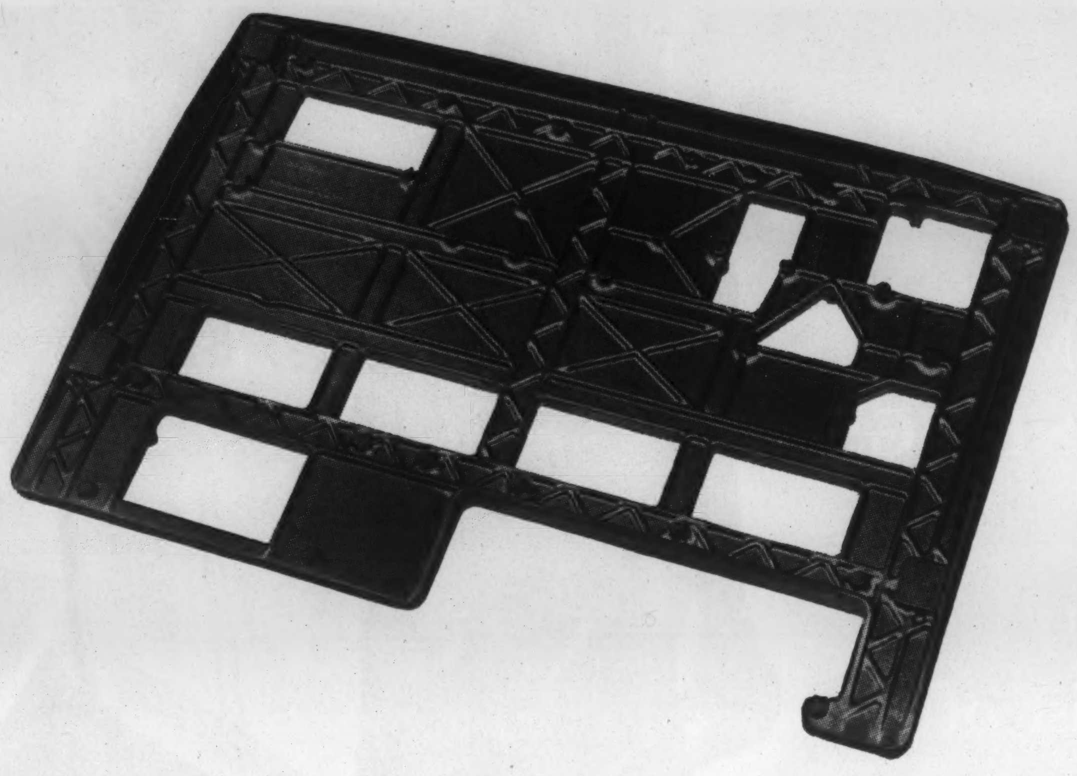


DUCTILITY

A CASE IN POINT—This ninety-six pound casting was made for the National Cash Register Co. of Nodulite®, Hamilton Foundry's ductile iron. The casting forms the base for the new Post-Tronic Accounting Machine. It measures 37½" by 23½" with sections varying from ¼" to 1½". Ductile iron was chosen for this part because of its ductility, dimensional stability, rigidity, and machinability.

Ductile iron has most of the engineering advantages of steel yet it can be designed with the same flexibility and cast with the same procedures used for gray iron. It has high strength: up to 120,000 psi minimum tensile strength in standard grades. It is tough: Charpy impact strengths up to 115 ft.-lbs. in standard grades. It is ductile: elongation is possible up to 25% after short time annealing. And it is wear resistant: spheroidal graphite particles provide for self-lubrication. Hamilton Foundry regularly casts 60-45-10, 80-60-03, 100-70-03, and 120-90-02 grades of ductile iron as well as high alloy Ductile Ni-Resist.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

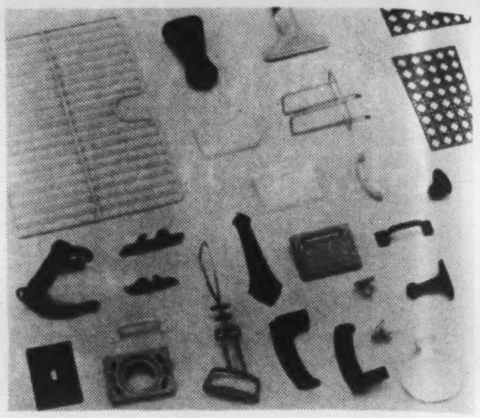
GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY

The Hamilton Foundry & Machine Co., 1551 Lincoln Ave., Hamilton, Ohio • TW 5-7491

For more information, turn to Reader Service card, circle No. 464

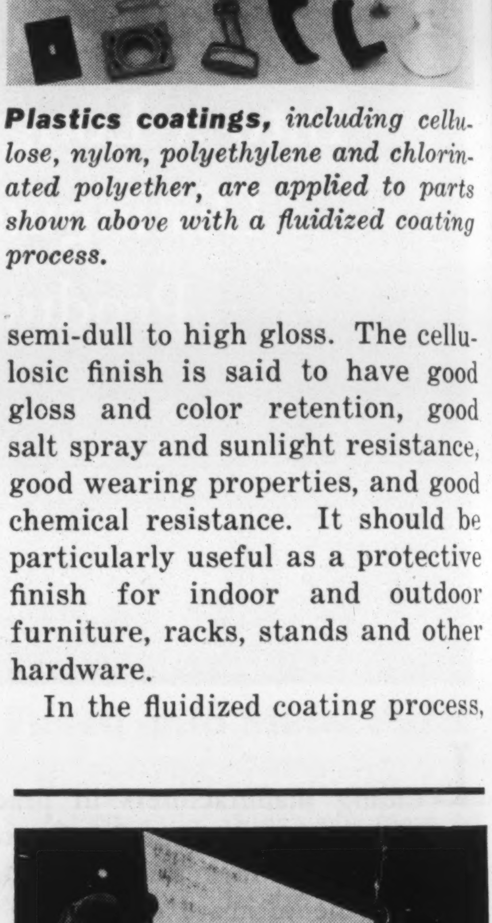
What's new IN MATERIALS



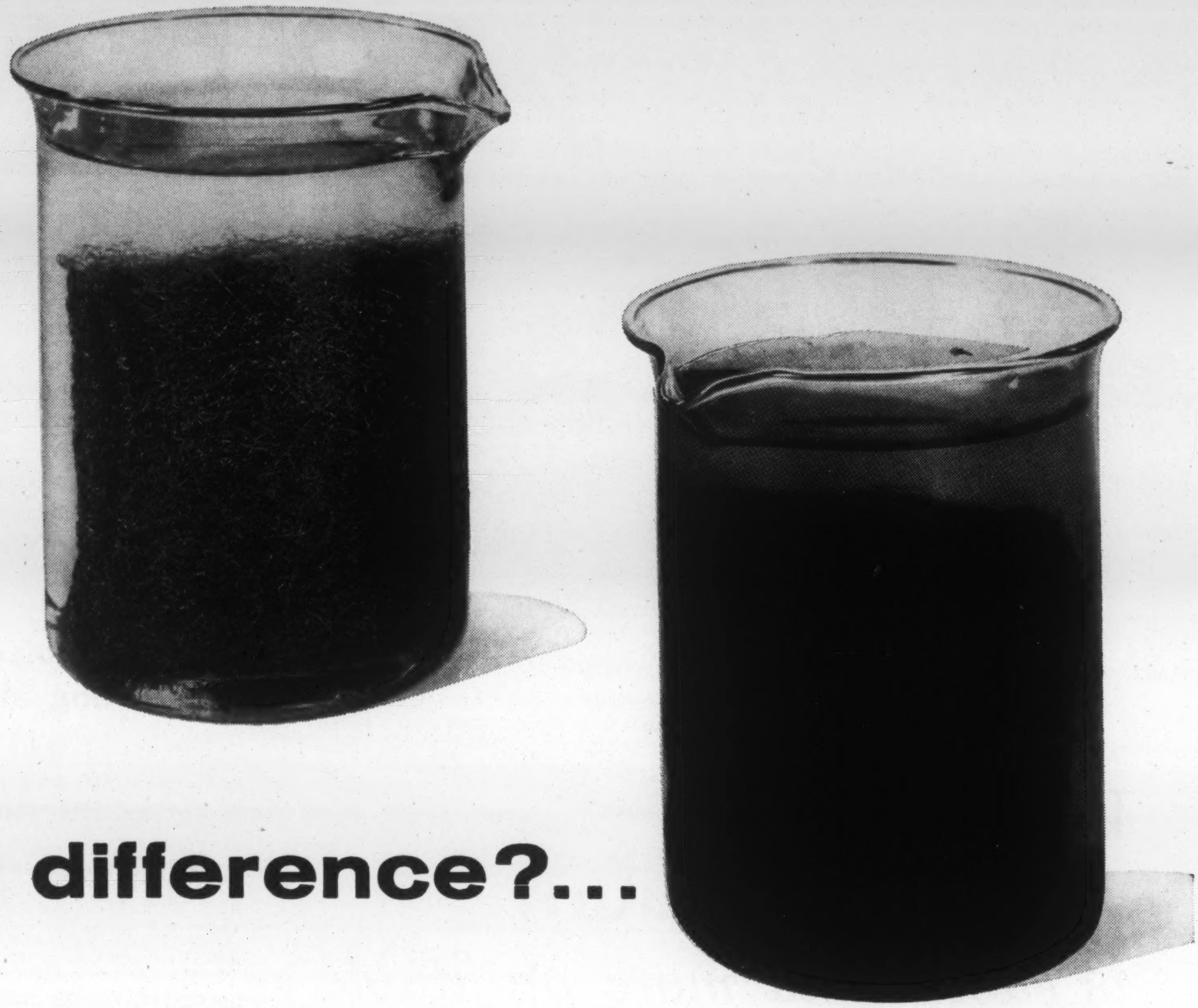
Plastics coatings, *including cellulose, nylon, polyethylene and chlorinated polyether, are applied to parts shown above with a fluidized coating process.*

semi-dull to high gloss. The cellulosic finish is said to have good gloss and color retention, good salt spray and sunlight resistance, good wearing properties, and good chemical resistance. It should be particularly useful as a protective finish for indoor and outdoor furniture, racks, stands and other hardware.

In the fluidized coating process,



Largest titanium plate—Pictured here is what is claimed to be the largest light gage titanium plate ever fabricated. Produced by Titanium Metals Corp. of America, the plate measures 75 by 224 in. and is 3/16 in. thick. The plate, made of Ti-75A titanium alloy, was produced for a large reactor vessel handling corrosive materials.



The difference?...

CORROSION PROTECTION *with* SOLVAY SODIUM NITRITE

Sodium nitrite protects steel—whether it is in the fine strands of steel wool, or in plates, pipes, or in machined parts such as gears. The *only* difference between the specimens shown above is that the beaker on the left contains a low cost .1% concentration of SOLVAY Sodium Nitrite.

SOLVAY Sodium Nitrite forms an invisible gamma oxide protective film that keeps metal surfaces corrosion-free. You can easily dip or spray it in solution, or add it to circulating water systems. Effective with steel or iron, it also reportedly suppresses degradation in aluminum, tin, monel, copper and brass. Where a more moisture resistant film is required, it can be combined with phosphates.

Write for test sample and full facts on SOLVAY Sodium Nitrite's many anti-corrosion applications.

Sodium Nitrite • Potassium Carbonate Caustic Soda • Calcium Chloride • Chlorine Sodium Bicarbonate • Ammonium Chloride Caustic Potash • Chloroform • Vinyl Chloride Methylene Chloride • Para-dichlorobenzene Methyl Chloride • Cleaning Compounds • Soda Ash • Hydrogen Peroxide • Aluminum Chloride Ammonium Bicarbonate • Carbon Tetrachloride Monochlorobenzene • Mutual Chromium Chemicals Ortho-dichlorobenzene • Snowflake® Crystals

SOLVAY®

SOLVAY branch offices and dealers are located in major centers from coast to coast.

Mail now for sample, information!

Allied Chemical

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL & DYE CORPORATION
61 Broadway, New York 6, N. Y.

Please send me without cost:

☐ Test sample of SOLVAY Sodium Nitrite

☐ Booklet—"Sodium Nitrite for Rust and Corrosion Prevention"

Name____________________

Position____________________

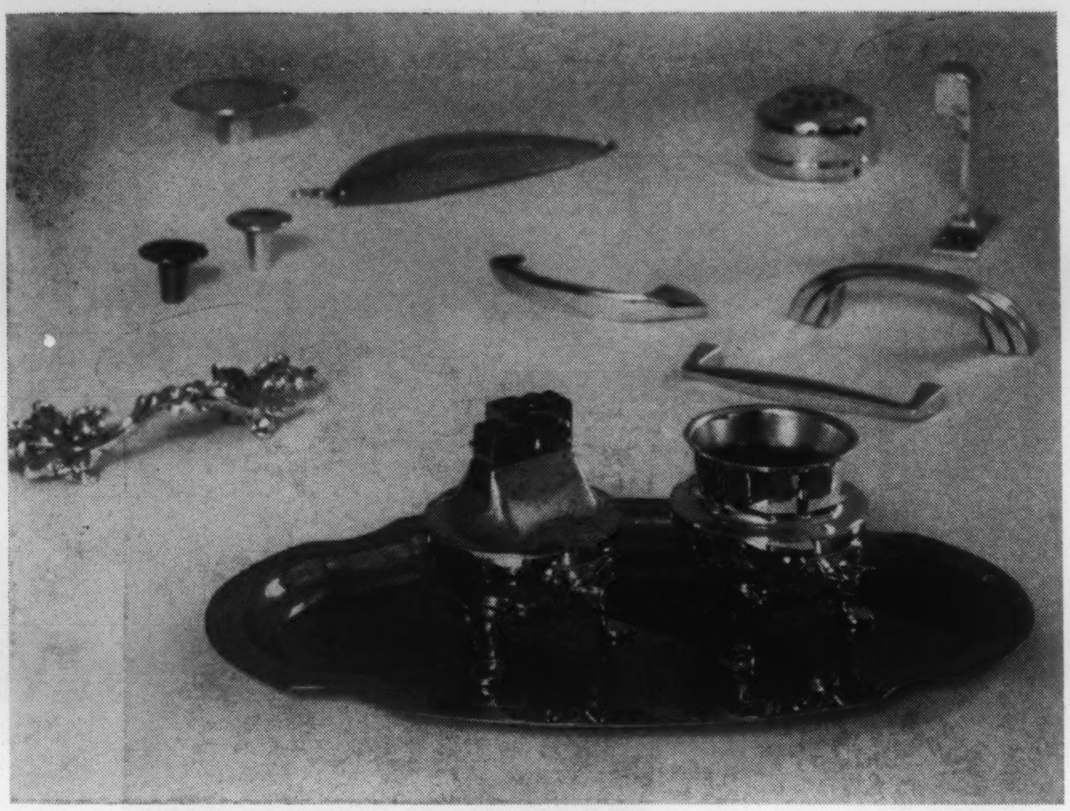
Company____________________

Phone____________________

Address____________________

City__________Zone______State______ EP-48

For more information, turn to Reader Service card, circle No. 578



Plated under vacuum, these articles have a high-sheen surface that lasts as long as conventionally plated pieces.

Why plating
with vacuum
is easier and more profitable

Without buffing or polishing, without corrosive cleaning baths, without highly skilled help, you can now cover articles like those shown above with a shimmering finish that lasts for years.

All it takes is a CEC vacuum coater and some inexpensive lacquers to make metal and plastic articles look silver, gold, copper, or a multitude of other colors and tones.

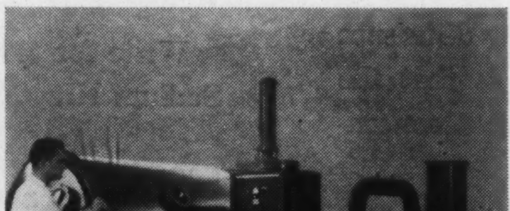
Vacuum-plating costs less. With a CEC vacuum coater you can plate thousands of pieces per day with unskilled labor.

New longer-lasting lacquers. There are on the market many lacquers which can make vacuum-plated articles wear as well as those plated in conventional ways.

The stayfast finish requires no retouching, or buffing, or polishing—just an easily applied coat of lacquer.

You can control film thickness easily and precisely. You can make surfaces electrically conductive *or* insulating as you wish.

For further information on this highly profitable process, write for information on the coaters, the lacquers, and the methods used.



1450 2½" diameter pieces per cycle, 3 to 6 cycles an hour—that's the production rate of this 48" CEC vacuum coater.

Consolidated Electrodynamics
Rochester Division, Rochester 3, N. Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

For more information, turn to Reader Service card, circle No. 486

parts to be coated are preheated and dipped into a fluidized bed of dry coating powders which bond by fusion onto the surface of the part. Parts so coated are said to be unmarred by sags, drips or irregularities in material flow. The process allows finishes to thoroughly penetrate recesses on complex shapes.

Modified Polyesters Are Strong at 500 F

Because of their light weight, high strength and good electrical properties, glass fabric-reinforced polyester resins are being considered for use in high speed aircraft and missiles. According to R. G. Nelb, of Naugatuck Chemical Co. (a division of U. S. Rubber Co.), polyester resins modified to produce highly crosslinked structures have good hot strength retention, have good heat resistance for long periods of time, and have good resistance to oxidation. Speaking in New York before the fall meeting of the Reinforced Plastics Group, Society of Plastics Engineers, Mr. Nelb outlined some properties of two new polyester resins, designated Vibrin 135 and Vibrin 136, recently developed by Naugatuck.

Vibrin 135

Described as a maleic anhydride-modified polyester resin with triallyl cyanurate as the monomer, Vibrin 135 is said to have a highly crosslinked structure in the cured state, resulting in exceptionally good heat resistance. Mr. Nelb says the resin can be cured by promoter-catalysts at room temperature, as well as by heat, ultraviolet light, radio frequency heat, and radiation. This versatility in curing permits the resin to be fabricated by hand lay-up, vacuum, pressure bag, matched die molding or casting. It may also be used in premixes.

(continued on p 206)

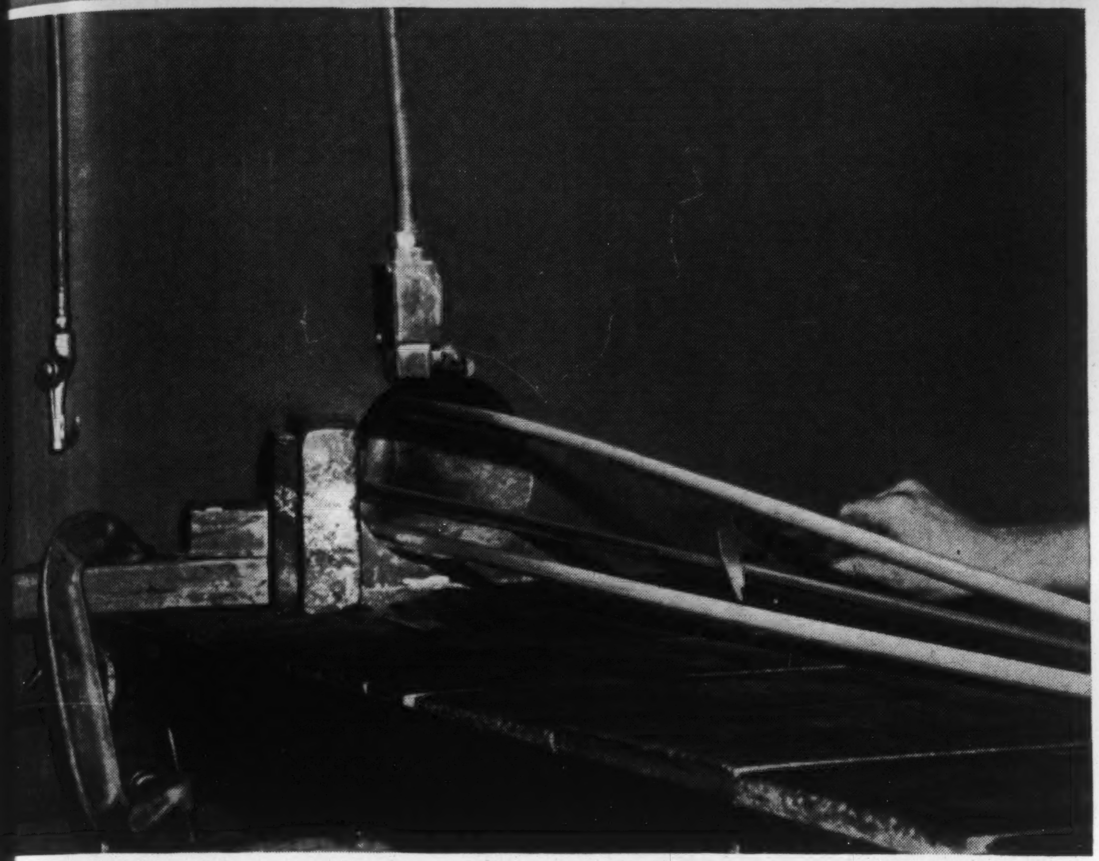
Tool Steel Topics

BETH LEHEM STEEL

e Pacific Coast Bethlehem products are sold
ethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor:
Bethlehem Steel Export Corporation



Showing extrusions leaving the press. The die of Cromo-WV tool steel is not visible.

Die made from Cromo-WV passes tough extrusion test

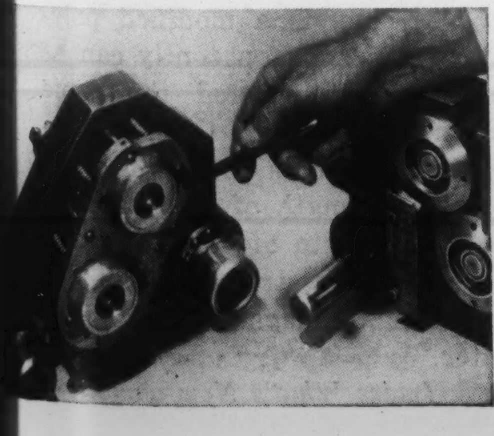
uality plus economy — that's the kind
a die steel they needed at American
luminum Extruders, Miami, Fla., to
roduce aluminum extrusions used as
ecorative trim. Our local tool steel dis-
ibutor, J. M. Tull Metal & Supply
o., Inc., recommended Bethlehem
romo-WV.

“We've had a lot of experience with
is grade,” they said. “Give it a try, and
e performance figures will speak for
emselves.”

That's just the way it turned out.
romo-WV was satisfactory in every
y. Hardened to Rockwell C-47, the die extruded about 2,500 lb of aluminum before polishing was required.

Cromo-WV, in addition to its 5 pct chrome, contains .30 pct vanadium. It is a modification of our popular Cromo-W, the original 5 pct chrome hot-work steel. Like Cromo-W, it combines red hardness, shock resistance, and resistance to heat-checking. It is an ideal grade for extrusion work.

Your Bethlehem tool steel distributor will be pleased to supply Cromo-WV, whether you want a production quantity or just enough to give it a trial.



IT'S TOPS FOR BOTTLE CAPS

Here's a die made of BTR (Bethlehem Tool Room) which was used in producing millions of tinplate bottle caps. The die was hardened to Rockwell C-61, and was redressed about every third month. BTR is our general-purpose manganese-chromium-tungsten grade of oil-hardening tool steel. Tough, and safe-hardening, you can count on it for extremely long wear.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

In Machining Operations, Chips Tell a Story

A good way to evaluate a machining operation is to examine the chips carefully. This step is particularly valuable in operations where large amounts of metal are removed at high speed.

Generally, the color and shape of the chips tell a story which, when properly interpreted, can lead to improvements in the operation. For example, when machining with high-speed steel tools, the chips produced should show some temper color (yellow or brown). If they do not, it means that speed and feed might be increased greatly, boosting the production rate on the machine. When machining with carbide or ceramic tools, the chips should always be highly temper-colored (purple or blue). If otherwise, you are probably “under-machining.”

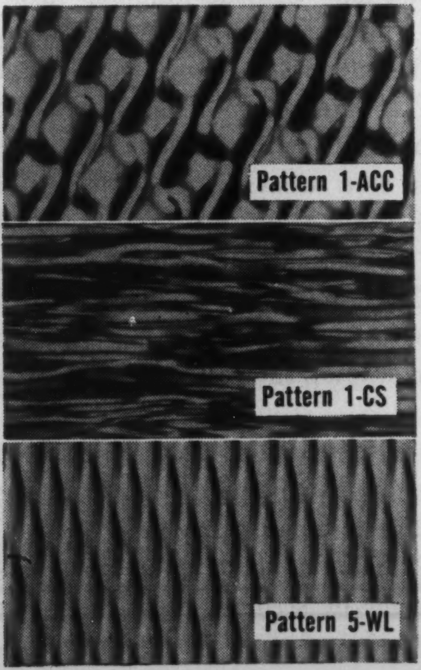
The shape of the chips will vary with the type of steel being machined, but comparison of chip shape under varying conditions may provide valuable information. The ideal chip shape, indicating ideal machining conditions, is like the letter “C.” Often the “C” can have a decided flourish, but this form of chip (on steel) is best. Generally, the secret of producing “C” chips lies in the proper balance of feed and depth of cut, versus speed. These factors should be varied whenever other types of chips are produced, to develop the best machining conditions.

Examination of chip shape is also of value for control purposes. For example, if “C” chips are being produced in a machining operation, and they become gradually longer or stringy, it indicates the tool is becoming dull, and requires resharpening.

It is difficult to establish more specific rules which apply to all machining operations, due to their variety and complexity. However, you can be sure that the proper control of chip color and shape will pay off in increased production.

For more information, turn to Reader Service card, circle No. 493

Maintenance-Free SERVICEABILITY achieved by Good Design and RIGID-tex METAL



This pattern in 302 stainless RIGID-tex Metal is used in airplane galleys as shown above.

Wherever surfaces are subject to hard usage, good design calls for RIGID-tex Metal. Its patterned texture presents a mar-resistant finish that hides scratches and scuff marks, retaining the original sparkling beauty and brilliance without maintenance.

All this . . . plus increased strength, greater rigidity, higher impact strength — fits RIGID-tex Metal into almost any product. There are more than 40 standard patterns from which to choose . . . in any metal . . . any color. RIGID-tex Metal is a challenge and inspiration to the designer. Write for literature and samples today!

Tell me more about RIGID-tex Metal.
☐ Send a copy of "Pattern Selector" showing all the standard patterns.
☐ Send a sample of RIGID-tex Metal.
☐ Send name of nearest distributor.
Name ....
Address ....
City .... *State* ....

RIGIDIZED METALS
CORPORATION
6604 OHIO ST. BUFFALO, N. Y.
WORLD-WIDE DISTRIBUTION

For more information, turn to Reader Service card, circle No. 394

What's new IN MATERIALS

PROPERTIES OF MODIFIED POLYESTERS REINFORCED WITH GLASS

Type ➔	135	136
Tensile Strength, psi		
77 F	38,100	66,000
500 F[a]	23,100	—
Flexural Strength, psi		
77 F	58,800	64,000
500 F[a]	40,000	40,000
500 F[b]	17,900	30,500
Compressive Strength, psi		
77 F	45,000	53,100
500 F[a]	30,000	33,500
Flexural Modulus, 1000 psi		
77 F	3.06	3.45
500 F[a]	2.55	2.55
500 F[b]	2.34	2.25

[a] Aged 30 min.
[b] Aged 192 hr.

Outdoor exposure tests conducted on glass fabric-reinforced Vibrin 135 polyester resin indicate it has a flexural strength of 50,600 psi after three months aging and 49,700 psi after one year of aging. After 30 days immersion in water, the laminate has a flexural strength of 53,100 psi, a tensile strength of 37,400 psi, and a compressive strength of 42,600 psi.

Research work at Naugatuck indicates that glass fabric is the best reinforcement for Vibrin 135. Mr. Nelb says the type of finish on the glass fabric is an important factor in determining the heat resistance of the cured resin; both 301 and Garan finishes are satisfactory, whereas other available finishes are not.

Vibrin 136

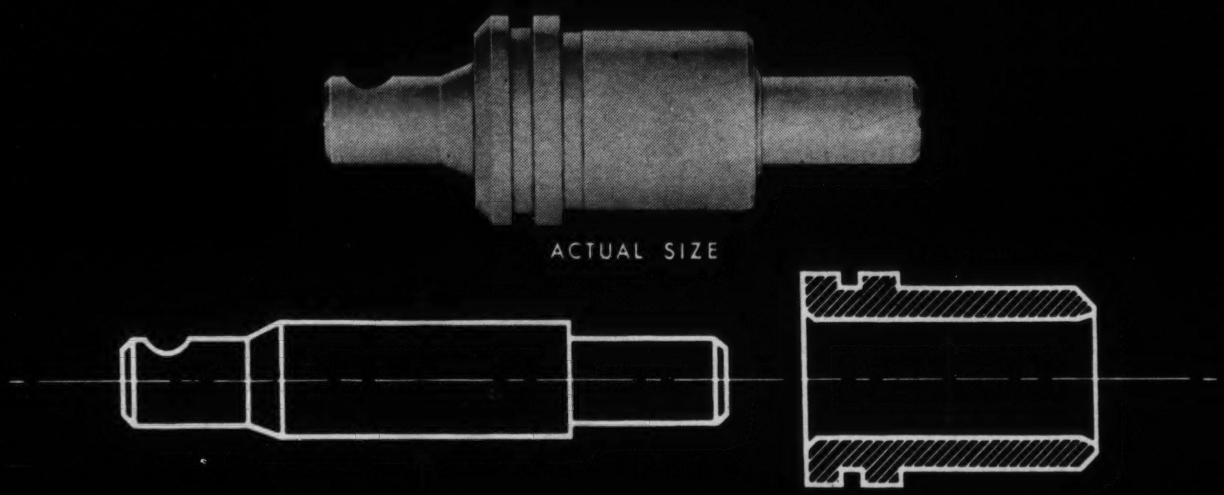
Still in the development stage, Vibrin 136 is said to be more resistant to oxidation and cracking at high temperatures than Vibrin 135. It, too, is a modified polyester resin and apparently can be cured and fabricated the same way as Vibrin 135. Glass fabric-reinforced Vibrin 136 resin has a flexural strength of 60,000 psi, a tensile strength of 54,600 psi and a compressive strength of 48,200 psi after 30 days immersion in water.

(more What's New on p 208)

For more information, circle No. 551 ➔

Coors CERAMICS

HIGH PRECISION TOLERANCES



SHAFT		BUSHING	
Diameter	0.000015	Diameter	0.000050
Taper	0.000010	Taper	0.000010
Camber	0.000010	Camber	0.000010
Out-of-Roundness	0.000010	Out-of-Roundness	0.000010

BENDIX AVIATION CORPORATION SHAFT AND BUSHING ASSEMBLY

VERY CLOSE TOLERANCES AND CLEARANCES ON ASSEMBLY PROVIDE FRICTION FREE ACTION

Coors Alumina Ceramic is used in roduction quantities by the Bendix viation Corporation for a shaft and ushing assembly that has tolerances as ose as ±0.000015. From one bushing another, Coors holds the diameter to ±0.000050. Between one shaft and another, Coors holds the diameter to ±0.000015. On both bushings and afts, taper, camber and roundness of dividual parts are held to 0.000010 tal.

Extremely close, match-fit sets of is assembly are made by selective fitting. Finishing within a few millionths is required to provide proper fits—exact clearance must be withheld.

These very close tolerances and clearances provide friction free action between the shaft and bushing. This, combined with the hardness and chemical inertness of the alumina ceramic, gives the assemblies long, trouble free service.

Guaranteed precision on a production basis permits the engineer to use Coors ceramics in applications where the physical properties of metals and plastics are unacceptable. Tolerances and finishes which can be obtained by Coors are:

Diametrical....................within 0.000030" total.
Taper................0.000010" per inch of length*.
Camber.............0.000010" per inch of length*.
Out-of-roundness..............................0.000010".
Surface flatness — less than 1 light band.
Equivalent surface finish —
3 to 4 r.m.s. microinch.

**(in lengths up to 3 inches)*

For a complete description of physical properties of Coors High Alumina Ceramics, write for Bulletin 1055A.

COORS PORCELAIN COMPANY

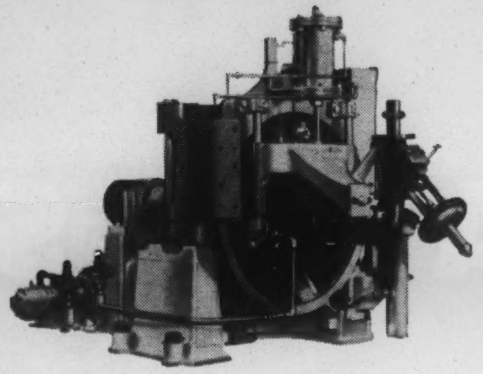
Manufacturers of High Strength Alumina Ceramics
GOLDEN, COLORADO

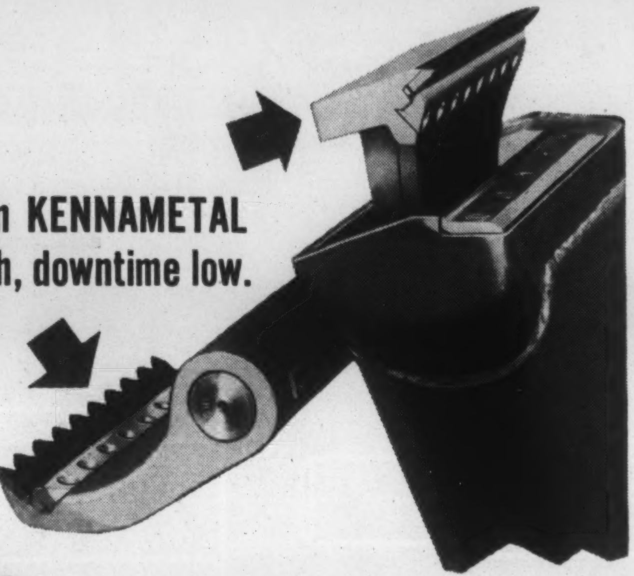
COORS PORCELAIN CO., 674 9th St., Golden, Colo.

Please send me detailed Bulletin 1055A on Coors High Strength Alumina Ceramics and Coors manufacturing facilities.

Name..Title......................
Company...
Address...
City..State......................................

Please refer to our 12-page catalog in Sweet's Product Design File





SHARPLES
SUPER-D-HYDRATOR

More than 400 of these centrifuges are now in service, with a combined daily capacity in excess of 1,600,000 cubic feet.

"Wear parts" made from KENNAMETAL help keep production high, downtime low.

Against $(NH_4)_2SO_4$

KENNAMETAL* components last 2 to 6 times longer . . .

On Unloader Knives: When processing corrosive Ammonium Sulfate (Coke Plant), the best life of any material tried for unloader knives on this crystal dehydrator was less than three months.† With Synthetic Ammonium Sulfate, the knives lasted little more than a month. By changing to knives made from Kennametal hard tungsten carbide, service life has been increased to twelve months or more with Coke Plant Sulfate, and up to four months with Synthetic Sulfate.

On Distributor Tips: With sulfates of either kind, Kennametal Distributor Tips in the feed assembly last up to eight months—double the life of any other alloys tried. Kennametal parts cost less in terms of longer life, increased production, and less downtime.

Chances are Kennametal can help *you* solve a problem involving corrosion, abrasion, erosion, or contamination. The Kennametal "family" of hard carbides includes grades three times as rigid as steel . . . grades that last up to 60 times as long as steel . . . grades that retain high strength at 2200°F and above or at subzero temperatures.

Let us tell you more about Kennametal and how it has helped others solve problems that may be similar to yours. Write to KENNAMETAL INC., Dept. MD, Latrobe, Pennsylvania.

*Trademark
†Based on an average daily throughput of 100-150 tons.

3146

INDUSTRY AND KENNAMETAL ...Partners in Progress

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

See the parts illustrated above and other machine components made of Kennametal and Kentanium at Booth 718

DESIGN ENGINEERING SHOW • Chicago, April 14-17

For more information, turn to Reader Service card, circle No. 538

Iridium Electroplate Withstands 2400 F

Iridium can now be applied to stainless steel and to molybdenum by a new plating process developed by Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va. Tests show that iridium plated molybdenum and stainless steel parts do not scale when exposed for 30 min at temperatures as high as 2400 F.

According to Melpar, iridium, because of its high melting point (4450 F), high hardness (170 Vickers), and excellent resistance to oxidation at high temperatures, should make an excellent protective coating for aircraft and missile parts operating at high temperatures.

A detailed report on how to electroplate stainless steel and molybdenum with iridium was given by Paul E. Ritt and James C. Withers, developers of the process, at the 44th annual convention of the American Electroplaters' Society.

The developers note that bright, ductile electrodeposits of iridium can be obtained by using a molten salt bath operating at a temperature of 950 F. The bath contains 70 parts of sodium cyanide and 30 parts of potassium cyanide by weight. Alternating current is introduced into the bath to form an iridium complex in the melt. Iridium is then electroplated onto metals from the cyanide melt with the passage of direct current. The most satisfactory deposits are obtained at current densities of 10 to 20 amp per sq ft.

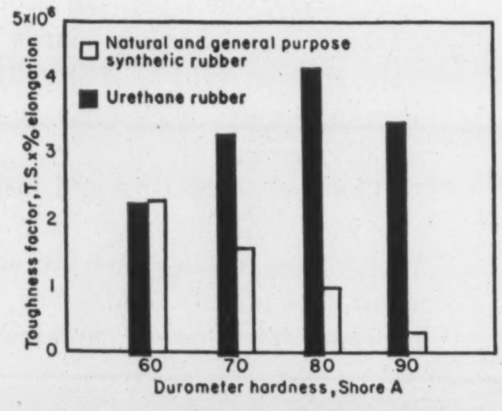
Synthetic Rubber Parts Hold Up Well in Water

Molded seals, diaphragms and o-rings made from a new synthetic rubber compound do not swell or deteriorate after immer-

URETHANE RUBBER

fits the tough assignments...

...and fills the property gap between rubbers and metals



TOUGHNESS FACTOR

. . . stays high as hardness goes up for cast urethane, compared here with other rubbers.

Mobay supplies basic chemicals and technology required for the manufacture of urethane rubber—latest addition to the growing list of urethane products for industry.

Urethane rubber is a new, chemically-engineered casting material developed for use in industrial parts where high load-bearing and long-wearing properties are critical requirements. It needs no waxes, clays, fibers or fillers such as are used in other rubbers to add functional properties lacking in the basic material. In urethane rubber, the molecular composition of the basic compound itself is modified to "build in" the range and combination of desired properties. You can specify—and get—the exact durometer, degree of elasticity, tensile strength, abrasion resistance and electrical properties you need.

What does this mean to you? If you are responsible for the selection of materials for your company's products, it means urethane rubber has opened up a broad new area on your materials selector charts. If you are a manufacturer, or responsible for production or maintenance costs on heavy-duty equipment, urethane rubber means economy because of the ease with which it may be cast into parts having difficult undercuts, slots, inserts, threads or other complex design features.

Get the full story on how urethane rubber can fit into your product's future. Write today, briefly outlining your area of interest. Technical data and sources of fabricating assistance will be forwarded promptly.

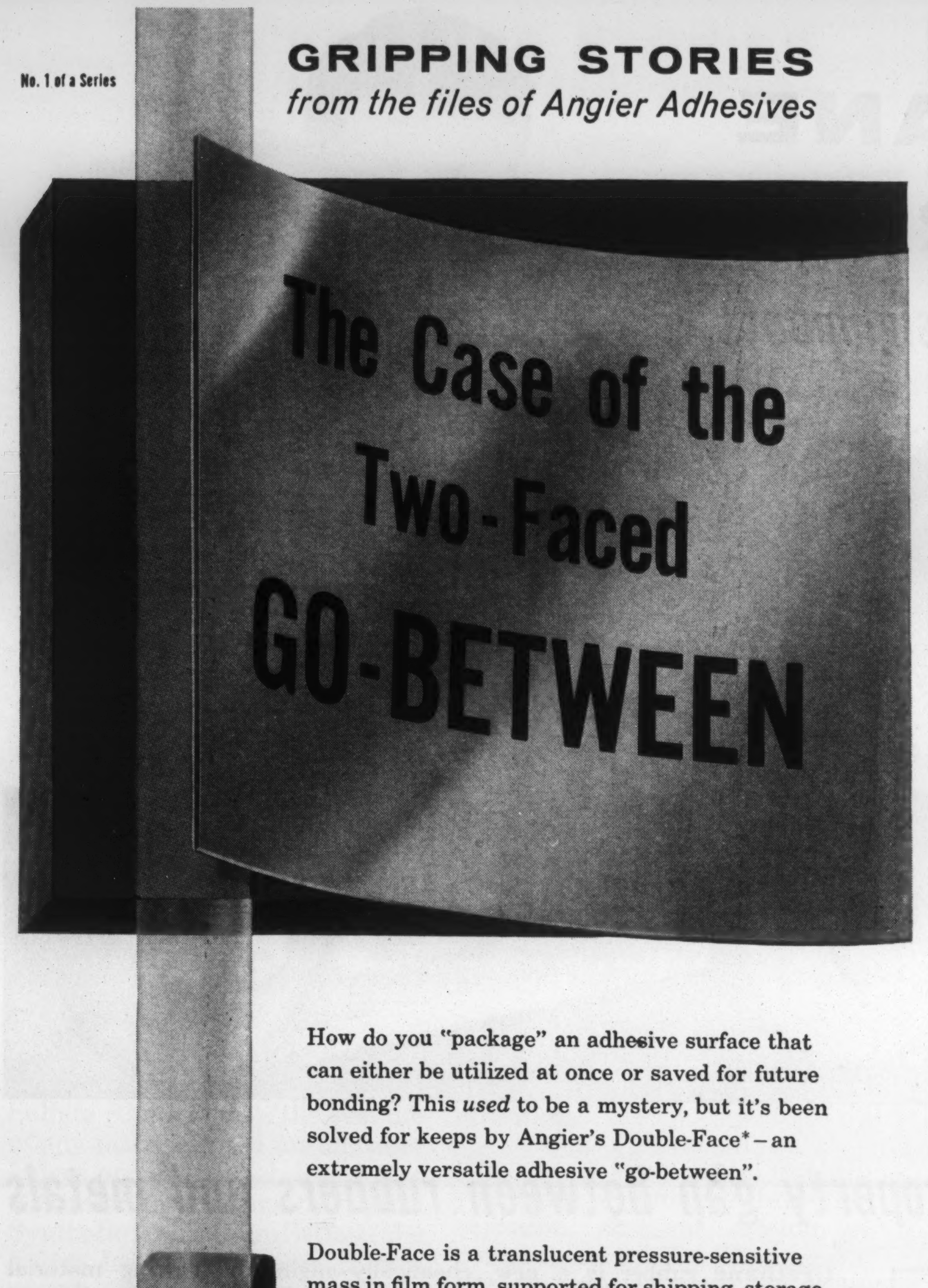
MOBAY CHEMICAL COMPANY
Dept. MD-2, Pittsburgh 34, Pa.

MOBAY
First in Urethane Chemistry

For more information, turn to Reader Service card, circle No. 489

No. 1 of a Series

GRIPPING STORIES
from the files of Angier Adhesives



How do you "package" an adhesive surface that can either be utilized at once or saved for future bonding? This *used* to be a mystery, but it's been solved for keeps by Angier's Double-Face*—an extremely versatile adhesive "go-between".

Double-Face is a translucent pressure-sensitive mass in film form, supported for shipping, storage and handling by a protective release paper . . . available in a variety of roll widths up to 54 inches, and in three different adhesive strengths.

You save time, money and materials with new Double-Face. There's nothing quite like it for both the temporary and permanent bonding of practically *any* materials.

*Trademark of Interchemical Corporation

Write for specifications and prices.

ANGIER ADHESIVES
DIVISION OF INTERCHEMICAL CORPORATION
120 Potter St. Cambridge 42, Mass. UNiversity 4-0375
Midwestern Plant: HUNTINGTON, IND.

For more information, turn to Reader Service card, circle No. 518

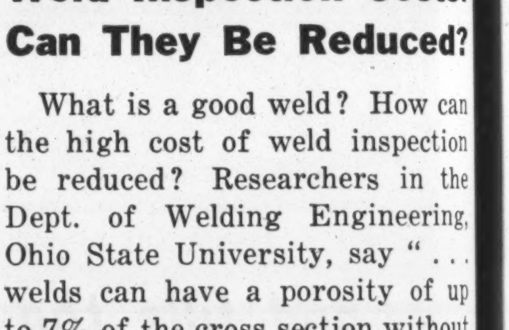
sion in water for 1440 hr, recent tests show. The compound, developed by Parker Rubber Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12 and called 37-021, also has good oil resistance. The new Parker compound is said to maintain low volume swell in water, and low shrinkage in dry-out conditions.

The rubber compound is suitable for seals and diaphragms in domestic laundry machines, agitator shaft seals, back-up gaskets, water conditioner seals, water valve seals, oil slinger rings, dishwasher and disposal seals, and liquid level switch diaphragms.

Weld Inspection Costs: Can They Be Reduced?

What is a good weld? How can the high cost of weld inspection be reduced? Researchers in the Dept. of Welding Engineering, Ohio State University, say " . . . welds can have a porosity of up to 7% of the cross section without materially changing the tensile strength, impact strength and ductility of the weld." In contrast, current inspection standards indicate that a weld is generally acceptable only if it has a very small amount of porosity.

The cost of testing and inspecting welds, often required by code to be done with elaborate equipment, frequently equals or even exceeds the cost of making the



Lincoln Electric Co.

***Welded specimen** with 6% porosity broke in tensile test outside the weld at 66,330 psi.*

HAYNES Investment-Casting Solves the *tough* design problems

INTRICATE DESIGNS
Mass-Produced Economically
... by Investment-Casting

Intricate shapes in hard-to-machine metals . . . sound metallurgical structures . . . close as-cast tolerances . . . smooth surfaces . . . are all available on a mass-production basis through HAYNES' investment-casting process. This modern mass-production method enables the design engineer to select the best alloy and most efficient design for an application. Desired parts can be made to specifications economically, regardless of how difficult or costly they might be to produce by other methods.

Haynes Stellite Company's extensive services and experience . . . complete tooling, production, quality control, metallurgical, and finishing facilities . . . plus a staff of more than 200 craftsmen . . . plus a selection of more than 25 alloys . . . guarantees that here you will obtain all the benefits the process has to offer.

For complete details, ask for our 40-page book. Write to HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, Literature Section, 30-20 Thomson Ave., Long Island City, N.Y.

Inspecting Castings—Every casting is carefully inspected to insure top quality. "Zyglo," gamma ray, x-ray, and hundreds of precision gages are available to make sure parts meet specifications.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

'Haynes," "Haynes Stellite," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

For more information, turn to Reader Service card, circle No. 569

"WEIRZIN® ARRESTS CREEPING CORROSION,"

SAYS CHIEF ENGINEER OF GRAND SHEET METAL PRODUCTS COMPANY, MELROSE PARK, ILL.

"Especially designed to withstand wind, weather, fire and rough handling." That's the manufacturer's description of a Grand Handy House. Metal used? Weirzin.

But listen to what else Grand Sheet Metal Products Company has to say about Weirzin electrolytic zinc-coated steel, as used in their outdoor storage-shelter-utility Handy Houses. From Chief Engineer Edward Rawson:

> "Weirzin material provides a very good surface for maximum paint adherence, which is most important for an outdoor application such as ours.
>
> "High corrosion resistance is also of the utmost importance. Weirzin answers this requirement very well since it arrests any creeping of corrosion where the surface may become scratched or abraded in service. In other words, the corrosion will not tend to spread beyond the damaged area."

What about your products? Have you considered lately how they can be improved economically? Send for free brochure on Weirzin for both outdoor and indoor use. Write Weirton Steel Company, Department E-15, Weirton, West Virginia.

WEIRTON STEEL COMPANY
WEIRTON, WEST VIRGINIA
a division of
NATIONAL STEEL CORPORATION

For more information, turn to Reader Service card, circle No. 484

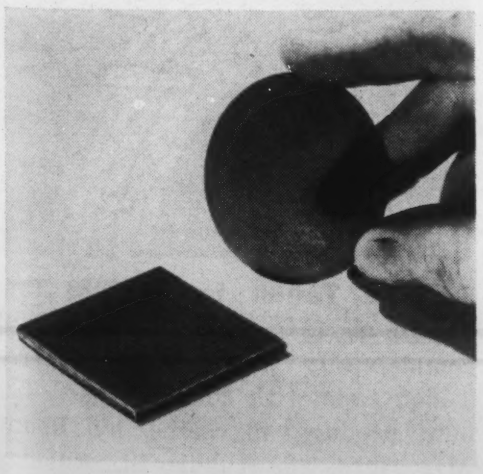
welds. The researchers say "... since results of the Ohio State University project show that up to 7% reduction of the cross section has little or no effect on weld strength . . . much of the inspection now required to locate and measure porosity in welds can be eliminated."

The researchers base their statements on findings taken from a series of tensile, bend and impact tests conducted on butt welds in ½-in. thick mild steel. The welds were made under controlled conditions with automatic submerged arc and inert gas processes in order to create a high degree of porosity in welds. The tests were made on welds machined flat to the ½-in. thickness of the plate.

Fluorocarbon-Glass Seals Liquid Nitrogen

Two glass-reinforced fluorocarbon plastics sheets are now in pilot plant production at Fluorulon Laboratories, Inc., P.O. Box 305, Caldwell, N. J. The outstanding property of both products seems to be their retention of strength at temperatures "from absolute zero to 425 F."

One product, called Fluoromat,

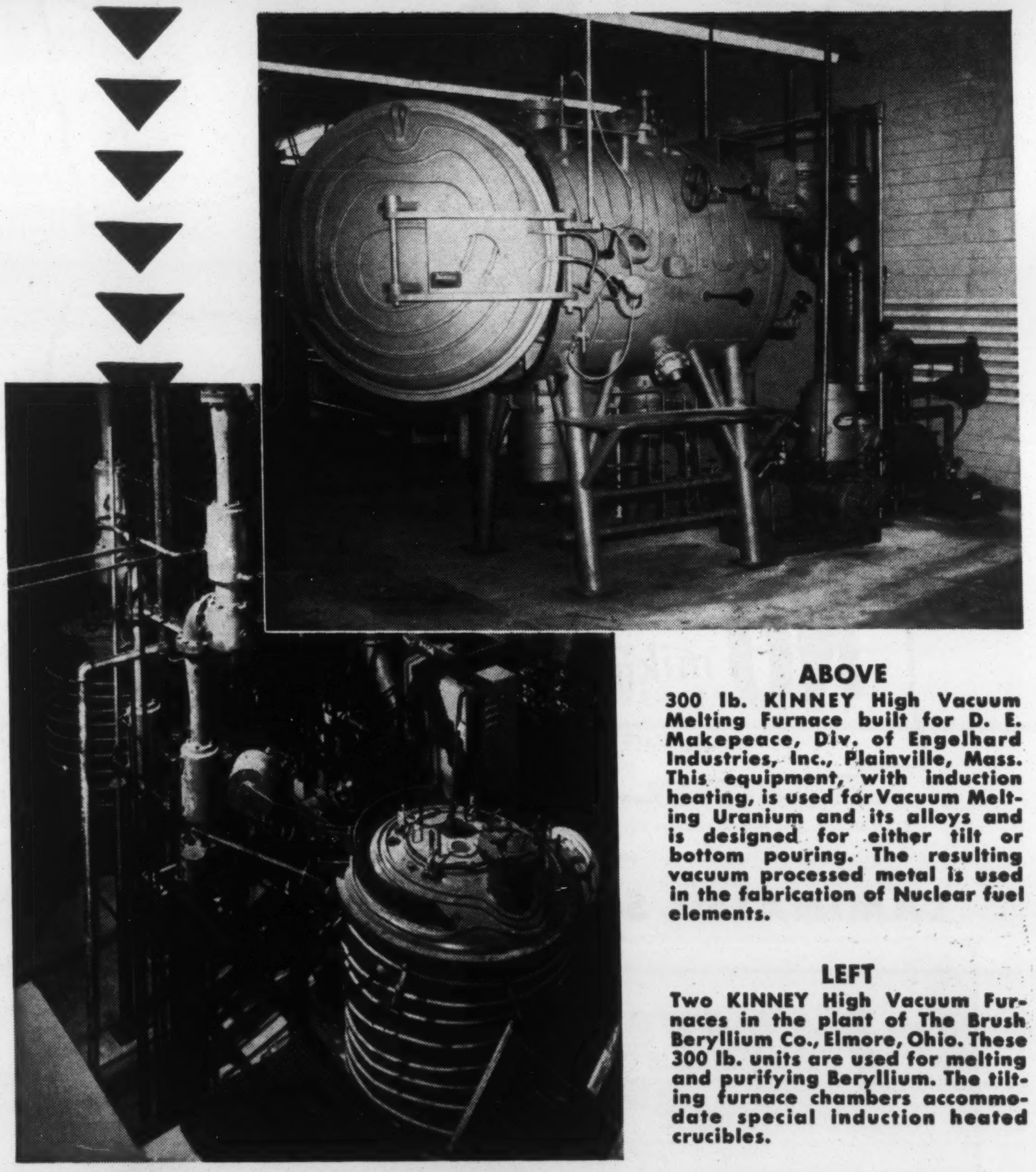


***Translucent** fluorocarbon plastics sheet reinforced with fine glass fiber grids (right) and fluorocarbon sheet reinforced with micro-pulverized glass filaments (left) resist both low and high temperatures.*

Kinney®

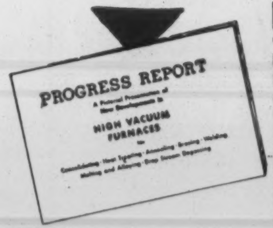
HIGH VACUUM FURNACES

The increasing demand for metals of high purity is now well beyond a few specialized applications. The obvious improvements in the properties of the metal on the one hand—and, the superior end product with minimum rejects, on the other, spell out the need for advanced type furnace equipment NOW! KINNEY High Vacuum Furnaces are exciting high interest among metallurgists both through their performance and the insight of your problem exhibited in their engineering! Whether your interests lie solely in ferrous metals or any of the so-called "exotic" group, you will want to know more about *What Kinney is Doing*.



ABOVE
300 lb. KINNEY High Vacuum Melting Furnace built for D. E. Makepeace, Div. of Engelhard Industries, Inc., Plainville, Mass. This equipment, with induction heating, is used for Vacuum Melting Uranium and its alloys and is designed for either tilt or bottom pouring. The resulting vacuum processed metal is used in the fabrication of Nuclear fuel elements.

LEFT
Two KINNEY High Vacuum Furnaces in the plant of The Brush Beryllium Co., Elmore, Ohio. These 300 lb. units are used for melting and purifying Beryllium. The tilting furnace chambers accommodate special induction heated crucibles.



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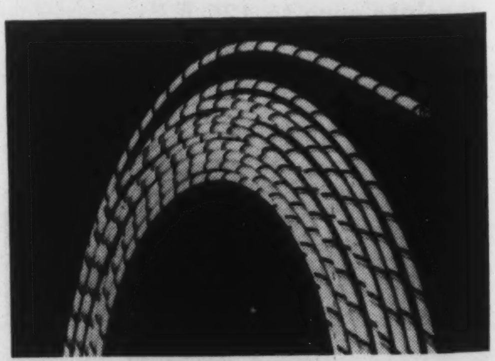
is a laminate of Kel-F fluorocarbon resin reinforced with fine glass fiber grids. It is available as a rigid, translucent or opaque sheet in thicknesses of 0.0312 in. and above.

The other product, called Fluoroglas, is a laminate of Kel-F resin reinforced with 15 to 18% by weight of micropulverized glass filaments. A cured Fluoroglas sheet is said to have a Durometer D hardness of 81, a 10 point increase in hardness over non-reinforced Kel-F resin.

Both glass-reinforced fluorocarbon products are recommended as seals and diaphragms for liquid nitrogen and oxygen.

Cadmium Plating Bath Checks Embrittlement

A heat treated SAE 4340 steel part usually picks up enough hydrogen in a cadmium plating bath to cause severe initial embrittlement of the part. Usually, but not always, embrittlement may be reduced substantially by baking the plated part (see MATERIALS IN DE-



Striped Teflon tape — The tape shown above is said to be the first commercially available, unsintered Teflon tape with color stripes. The new product, marketed by Bonny Mfg. Corp., 339 Auburn St., Auburndale 66, Mass. and called "Bonnytape," is currently used as a wire insulating material. It is available in widths of ¼ to 1 in. and can be provided in any specified color.

Proved by continuous 800 hour salt spray test!

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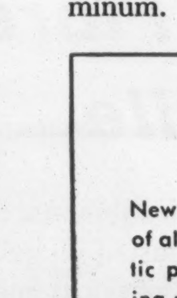

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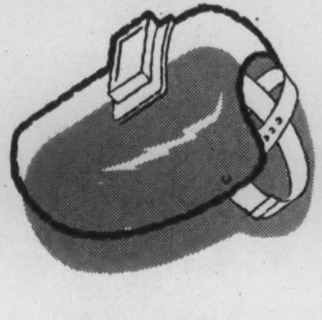
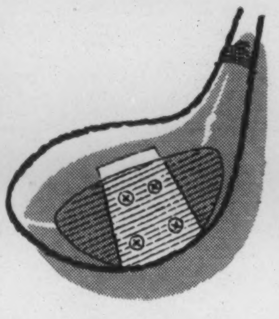
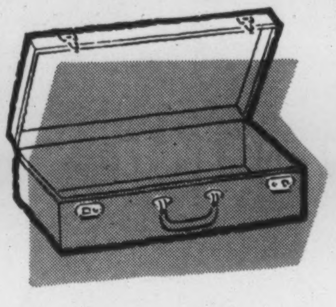
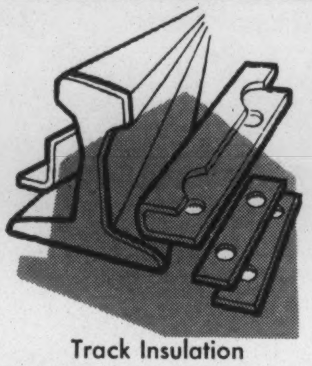
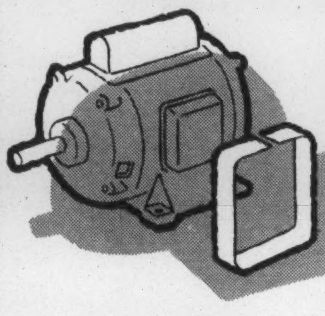
A few typical applications of Taylor Vulcanized Fibre

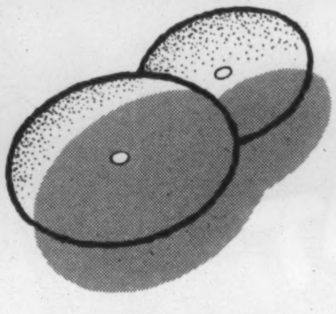

Welders' Helmets

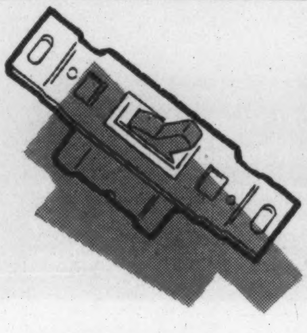

Golf Club Face Inserts

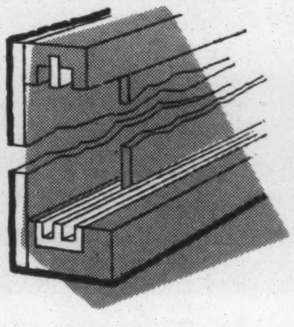

Carrying Cases

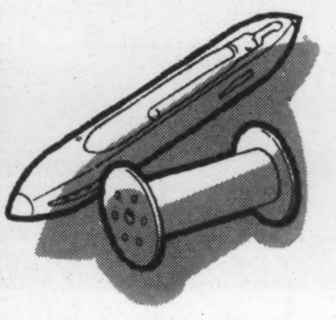

Track Insulation


Motor Insulation


Abrasive Discs


Switch Parts


Sliding Door Guides


Shuttles and Bobbin Heads

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LAMINATED PLASTICS VULCANIZED FIBRE

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SIGN ENGINEERING, Aug '57, p 186). Recently, a group of three research engineers at Lockheed Aircraft Corp. developed a modified cadmium cyanide plating bath that shows promise of overcoming hydrogen embrittlement in heat treated SAE 4340 steel parts.

The three engineers, Dr. W. F. Hamilton and M. Levine, of Lockheed's Metallurgical–Chemical Research Dept., and R. C. Mauer, of the company's Electrical Research Dept., discussed the results of their work at the SAE National Aeronautic Meeting held recently in Los Angeles.

Modified bath

Although exact composition of the modified cyanide bath was not revealed, the authors mention that nitrate ions are added to the bath to suppress hydrogen formation. A trace of an organic agent is also added to maintain the desired covering properties of the bath. The authors say, "Tests over the past year in a 200-gal pilot plant tank show that the modified bath is no more difficult to maintain in production line use than a standard cadmium cyanide bath. Bend, reduction of area and notch tensile tests indicate that heat treated SAE 4340 steel parts can be plated in the modified bath without apparent embrittlement."

Before developing the modified cyanide bath the engineers investigated two other types of baths in the laboratory, a cadmium fluoborate and an organic cadmium bath. They found that parts plated in the fluoborate bath were usually brittle after baking and that parts plated in the organic bath were not properly plated because of the bath's limited throwing power. The organic bath was cadmium iodide in dimethyl cyanamide.

Plating conditions

The authors say that a check of general plating conditions in several Los Angeles electroplating shops led to their development of the modified bath. What they

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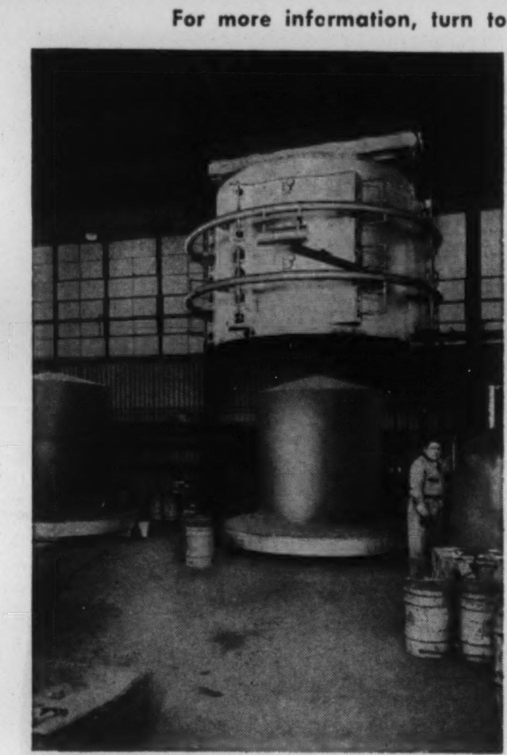
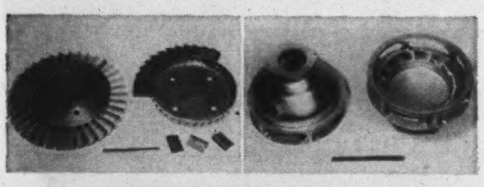


The 72-inch dia. hydrogen atmosphere furnace being lowered over a loaded furnace bell. Detroit plant.



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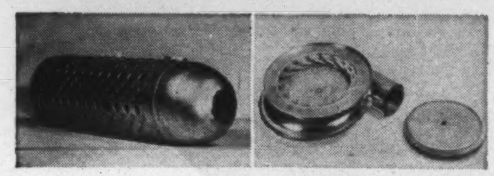

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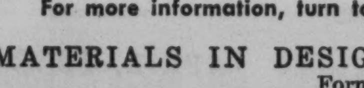

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found is summarized below:

1. None of the platers seem to regulate plating by current density. In most cases an ammeter is part of the circuit but is used only as a guide to avoid overloading of the power source.

2. There is considerable variation in plating voltage among the different platers; this appears to be a function of bath composition.

3. No rigid time schedule is followed by any platers. The length of plating time is usually controlled by the amount of time necessary to get the next batch of parts ready for plating.

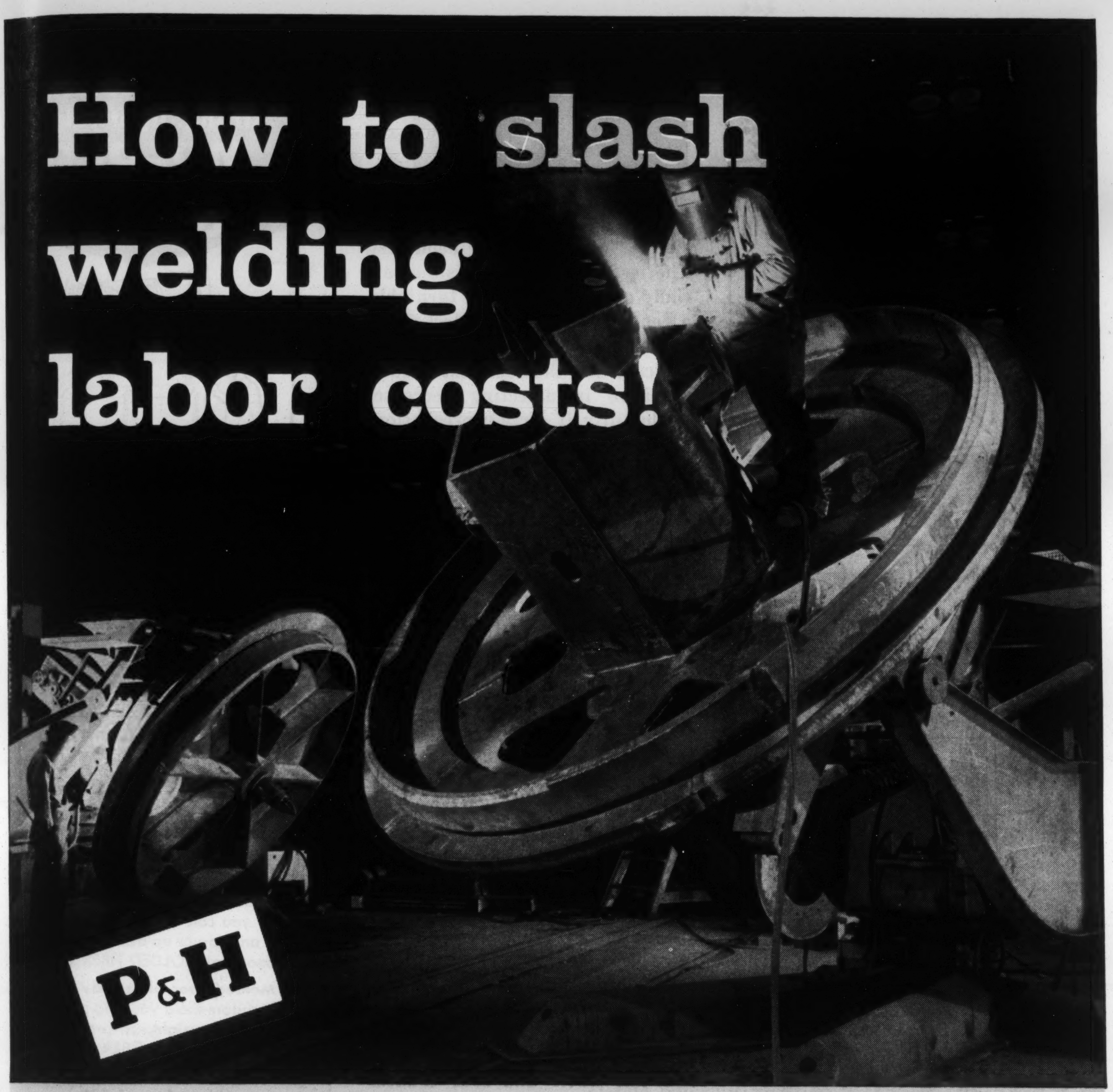
4. No immediate correlation between plating conditions in the various electroplating shops and embrittlement is apparent.

Current densities

Since no correlation between general plating conditions and embrittlement was established, the investigators performed tests on two representative plating solutions to determine if current density causes hydrogen embrittlement. They found that plating at rather low current densities to a given thickness results in slightly more initial embrittlement than plating at higher densities. This difference is apparently due to the increased time required to deposit the same amount of cadmium at lower current densities than at higher ranges. Generally, if low or medium current densities are used, a higher density, lower porosity, cadmium plate results and relief from hydrogen embrittlement by baking is less effective.

As a result of their tests on current densities, the investigators recommend that all high strength SAE 4340 steel parts (ultimate tensile strength above 260,000 psi) be plated at a current density above 60 asf.

In order to check samples plated in various electroplating shops and in Lockheed's laboratory the investigators devised a relatively



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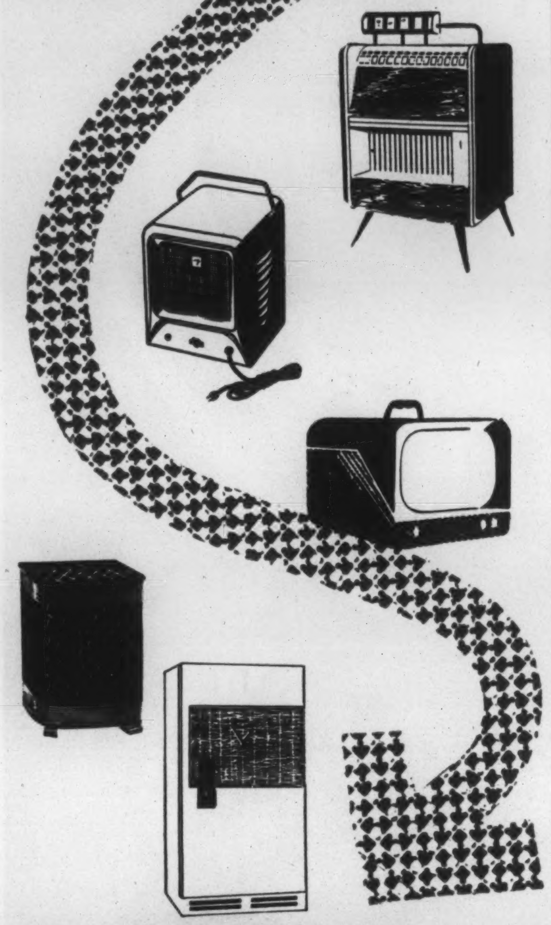

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simple "constant rate" bend test. The test apparatus consists essentially of a motor driven turntable, a centrally located mandrel and a specimen holder. Preliminary tests indicate that the bend test is quite sensitive in detecting decreases in ductility if certain precautions are observed. The specimens used in the work are round bars, 1/8 in. in dia and 5 in. long, made from SAE 4340 steel and heat treated in a neutral salt bath.

Steel Pipe, Tubing Resist Corrosive Fluids

Three steel companies have recently introduced corrosion resistant steel pipe and tubing for the oil, chemical, paper, aircraft and atomic energy industries.

1. Plastics-lined pipe

Jal-Jacket is the name given to Jones & Laughlin Steel Corp.'s new type of corrosion resistant steel pipe. It consists of a rigid polyvinyl chloride (PVC) tube which is jacketed with an electric resistance welded steel pipe.

J&L says the pipe can be used in oil fields to carry highly corrosive salt water and sour crudes. The steel-jacketed PVC pipe, which is manufactured at J&L's Electricweld Tube Div., Oil City, Pa., will be available in 20-ft mill lengths in 2, 3 and 4-in. nominal o.d.'s.

2. Stainless steel tubing

Seamless stainless steel tubing, called Lustraloy, is now available from Summerill Stainless Tube Div., Columbia Steel and Shafting Co., Carnegie, Pa. The tubing, available in sizes from 3/8 to 1½-in. o.d. and 0.020 to 0.109-in. wall thickness, is made by a series of closely controlled operations including cold reducing, bright annealing and lubricated drawing. These operations are said to give the tubing a mirror-like interior. The tubing should be of interest to fabricators of heat exchangers, condensers, chemical apparatus,

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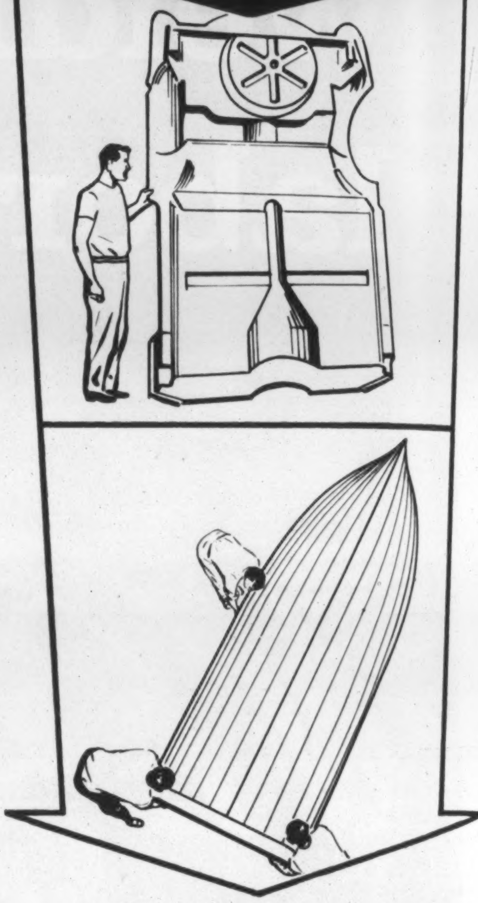

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Chief Test Engineer

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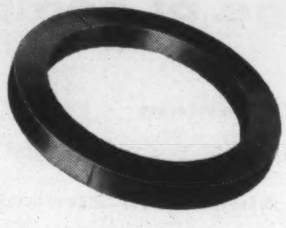

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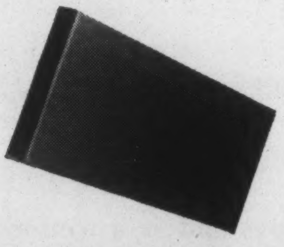
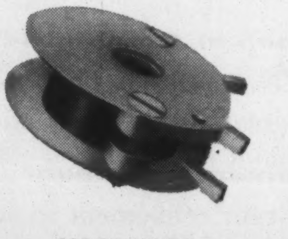


JET ENGINE PUMP VANE



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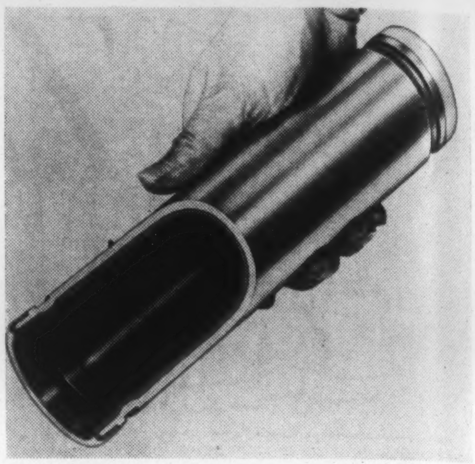
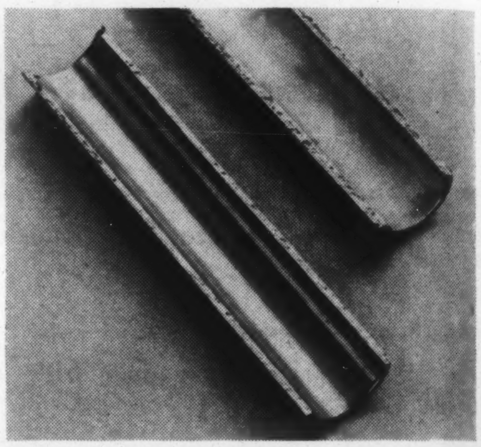


Cut-away view *shows J&L's plastics lined steel pipe.*



Interior finish *of Columbia Steel Co.'s stainless steel tubing (left) as compared to ordinary rod drawn tubing (right).*

paper mills, aircraft hydraulic lines, and atomic energy equipment.

3. Stainless clad pipe

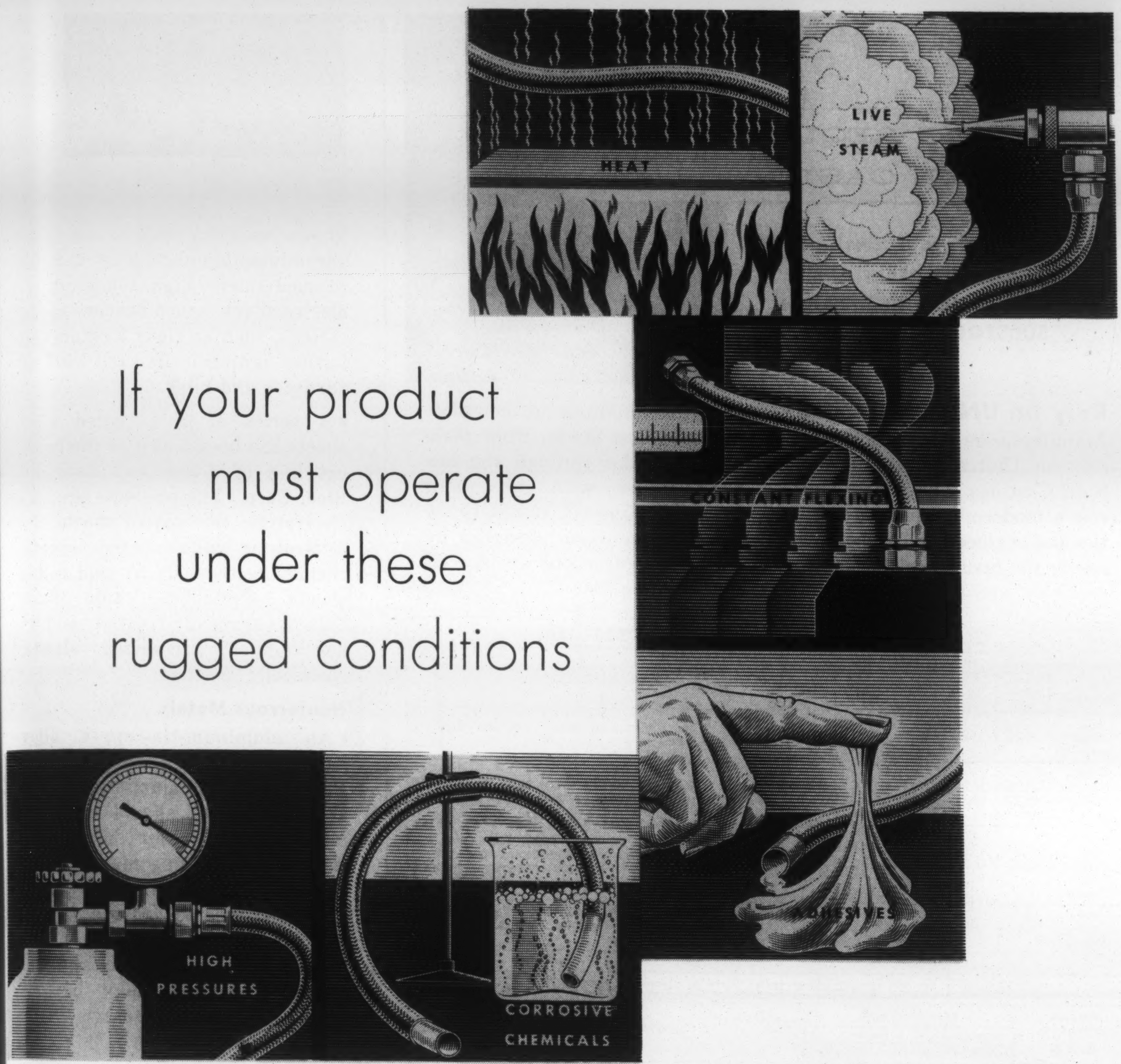
Lukens Steel Co., Coatesville, Pa., is marketing a new stainless steel clad, carbon steel pipe for handling corrosive fluids such as nitric acid. The inside surface of the pipe is a layer of solid stainless steel, and is permanently bonded to a heavier outer layer of carbon steel. The pipe is available in sizes as small as 4 in. in dia.

Other News . . .

Ferrous Metals

▶ A new electrical resistance alloy has been developed by Hoskins Mfg. Co., Detroit 8. The material,

If your product
must operate
under these
rugged conditions



you'll get better market acceptance by using hose of TEFLON® TFE-fluorocarbon resin

In designing for durability, it's best to specify hoses made with Teflon* TFE-fluorocarbon resin. Wherever lines carrying corrosives are subject to vibration, impulsing or flexing, hose of TFE resin gives superior performance. Few chemicals known to man have any effect on the resins. Even the non-flammable hydraulic fluids have no effect. The hose can operate continuously at 500°F., and can be built to withstand 3,000 psi. It handles live steam without failure and repels adhesion of sticky or viscous substances.

The extra safety and reliability of hose made with Du Pont TFE resin may well mean better market acceptance of your product. See your hose dealer or write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 234 Du Pont Bldg., Wilmington 98, Del.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

*Teflon *is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.*

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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

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SPECIFIC REQUIREMENTS IN STEEL CASTINGS?

- √ **TENSILE STRENGTH**
- √ **ABRASION RESISTANCE**
- √ **CORROSION RESISTANCE**
- √ **SUBSEQUENT HEAT TREAT**

Rely on UNITCASTINGS! Manufacturers have learned to rely on Unitcast's Specification Steel Castings. They know Unitcast's modern production facilities and engineering "know-how" assure the finest steel castings of *consistent uniformity!*

Unitcast produces a complete range of cast steels, from plain carbon grades through the low alloy ranges—with subsequent heat treat service. Listed below are six basic steels produced by Unitcast. Variations or special steels on request.

CARBON STEEL CASTINGS

TYPE OF CASTING	PHYSICAL PROPERTIES Tensile Strength p.s.i.	Yield Point p.s.i.	Elongation In 2"	Reduction of Area	Brinell Hardness	GENERAL CHARACTERISTICS
LOW CARBON [Grade B Soft]	60,000	30,000	25%	40%	120-140	Comparable to SAE 1020. Ideal for carburizing purposes. Weldability excellent. High ductility.
MEDIUM CARBON [Grade B Medium]	70,000 [Min.]	38,000 [Min.]	24% [Min.]	36%	140-170	Comparable to SAE 1025. Good machinability. Above average physical properties. Weldability excellent. Good ductility.
MEDIUM HIGH CARBON [Grade B Medium High]	80,000	43,000	18%	30%	170-190	Comparable to ASTM-A-148-46T 80—40. Slightly higher carbon than "Medium" grade with higher tensile properties. Decreased ductility. Water quench will increase hardness. Pre-heating and post-heating recommended for welding.
HIGH CARBON [Grade B High]	85,000	53,000	17%	25%	179-217	Comparable to SAE 1045. Attained higher tensile properties result in slightly less ductility. Suitable for high surface hardness. Welding difficult unless pre-heated and post-heated.

ALLOY STEEL CASTINGS

PHYSICAL PROPERTIES*	HEAT TREATMENT Normalized Drawn	Oil Quenched 1200°F Drawn	Oil Quenched 900°F Drawn	GENERAL CHARACTERISTICS
T-LOY 34				
Tensile Strength p.s.i.	90,000	105,000	150,000	Comparable to SAE or AISI 8632. Oil quench produces excellent tensile strength properties ranging to 150,000 p.s.i., coupled with high ductility, wear resistance and immunity to temperature changes. Specific areas may be flame or induction hardened.
Yield Point p.s.i.	60,000	85,000	125,000	
Elongation in 2"	20%	17.0%	10.0%	
Reduction of Area	40%	35.0%	25.0%	
Brinnell Hardness	187-217	217-246	305-342	
T-LOY 42				
Tensile Strength p.s.i.	100,000	120,000	175,000	Superior to SAE or AISI 8640. Recommended when high strength and hardness are desired in the normalized and drawn condition. Deeper hardening obtained by oil quench and draw with tensile up to 175,000 p.s.i High degree of hardness will be attained with spot or flame and air cooling. Water quench not recommended.
Yield Point p.s.i.	75,000	100,000	145,000	
Elongation in 2"	12%	12%	10%	
Reduction of Area	25%	28%	25%	
Brinell Hardness	217-246	250-280	350-380	

* Physical properties based on a .505" test bar turned from a standard 1⅛" cast test coupon

NOTE: Certified copies of complete test records—plus special test reports on each heat of steel—are provided to Unitcast customers on request.

Let Unitcast's engineers help you select the *right* castings for your requirements. Write or call today for detailed specification sheets. No obligation, of course!

Unitcast

SPECIFICATION STEEL CASTINGS

UNITCAST CORPORATION • Toledo 9, Ohio

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known as Alloy 835, is an iron-chromium-aluminum alloy for use in moderately high temperature, electrical resistance heating applications, such as cigar lighters, oil burner igniter coils, and electric furnaces and kilns.

▸ A series of zinc coated steel sheets has been added to the product line of Jones and Laughlin Steel Corp. The products are: 1) electrolytic zinc coated sheets; 2) electrolytic zinc coated sheets, chemically treated; 3) cold rolled sheets, electrolytic zinc flash coated, chemically treated; and 4) hot dipped galvanized sheets, chemically treated.

Nonferrous Metals

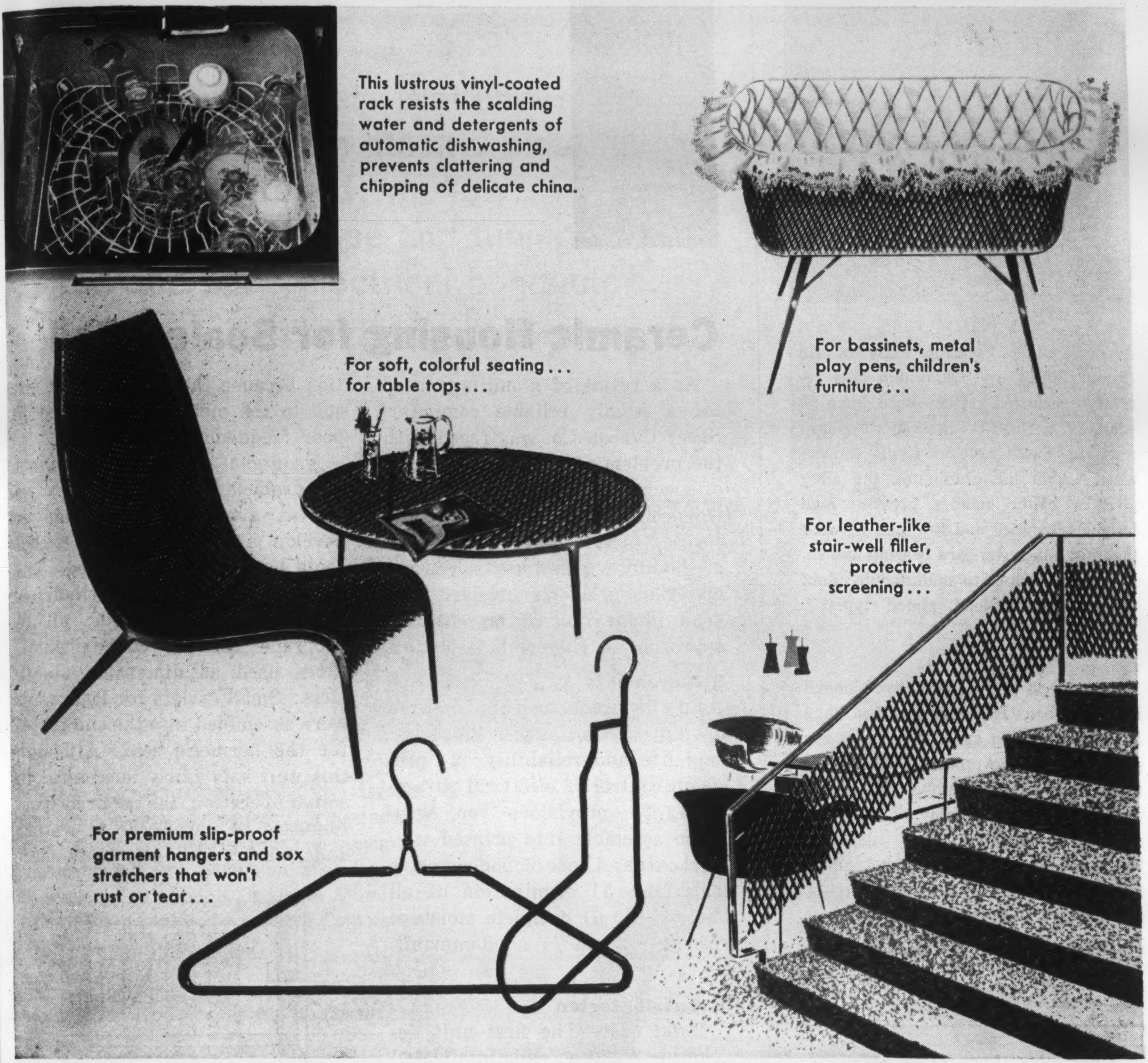
▸ An aluminum-tin-copper alloy has been developed for bearings. Both the tin and aluminum phases are continuous; should metal-to-metal contact occur between a shaft and a bearing made of this alloy a supply of tin is available at the surface to provide a thin, soft layer over the aluminum and thus inhibit surface breakdown. More information may be obtained from Tin Research Institute, Columbus, Ohio.

Nonmetallics

▸ A polyethylene resin specifically designed for molded plastics housewares such as dishpans, wastebaskets, trash cans and other large pieces, has been introduced by the Polychemicals Dept., E. I. du Pont de Nemours & Co. The low density resin, designated Alathon 18, sells for 32½¢ per lb in truckload quantities.

▸ A composite bearing material, composition of which has not been revealed, has been developed by Crane Packing Co., Morton Grove, Ill., for both sliding and rotating dry bearing service at temperatures up to 500 F. The material, known as Chemoloy, is said to withstand speeds up to 1000 fpm and loads up to 100 psi. It has a coefficient of friction against polished steel of 0.04.

NEW WAY TO UPGRADE YOUR PRODUCTS: VINYL COATINGS



This lustrous vinyl-coated rack resists the scalding water and detergents of automatic dishwashing, prevents clattering and chipping of delicate china.

For bassinets, metal play pens, children's furniture . . .

For soft, colorful seating . . . for table tops . . .

For leather-like stair-well filler, protective screening . . .

For premium slip-proof garment hangers and sox stretchers that won't rust or tear . . .

Colorful, leathery coatings for wire and expanded steel

Tough leather-like coatings of vinyl can create profitable new markets for you with wire and expanded steel products. Colorful coatings up to 1/16" (60 mils) thick can be deposited on heavy wire, rod stock, or expanded steel in *one dip*. Or by *spraying* it on.

You can make the elastomeric coatings soft and rubbery—or as hard as tire casing. Make the finishes glossy, matte, or even *crinkled*. And in any color you choose. The characteristics of the final coating are determined by the formulation. After spray or dip application, a short heat cure "sets" the resin and permanently bonds it to the metal.

Write for sources of vinyl in liquid form for coating metal, glass, or wood. Get a head start on investigating the new, profitable ways to use wire and expanded steel—vinyl coated for resilience, color and premium appearance. Write today!

Monsanto manufactures a wide variety of plasticizers and Opalon® resins for formulators of these high-quality vinyl dispersions.

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STRAITS
TIN
REPORT

MALAYAN TIN BUREAU

New developments in the production, marketing and uses of tin

A new engine bearing alloy of tin (about 20%) and aluminum was recently perfected after more than 3 years of testing. Of meshed tin-aluminum, in which the tin forms a lacework within the aluminum, the alloy gives a better balance between high fatigue resistance and low rate of wear than any other standard bearing known. It is also cheaper to manufacture than ordinary copper-lead plated types.

★ ★ ★

In his address to the Legislative Council in December, His Majesty the Yang di-Pertuan Agong again stated that the policy of his government will be to assist the tin and rubber industries, upon which the economy of the Federation of Malaya largely depends. "My government realizes it cannot maintain or increase the prosperity of the country unless it renders every assistance possible to both these industries," he said.

A new alloy of tin (13%), aluminum and titanium shows very good high-temperature characteristics. It is now being used in Europe for turbine parts in aircraft engines.

All modern dredges used in Malayan tin mining are now powered by electricity. The equipment for a single dredge may cost close to $170,000.

Ask us to send you TIN NEWS, a monthly letter. It will keep you posted on tin supply, prices, new uses and applications.

The Malayan Tin Bureau
Dept. 24D, 1028 Connecticut Ave., Washington 6, D.C.

For more information, circle No. 418

MATERIALS AT WORK

Ceramic Housing for Sealed Coil

As a result of a military need for a highly reliable computer, Speer Carbon Co. was faced with the problem of designing a series of special hermetically sealed coils which had to satisfy exceptionally severe test requirements. The method by which Speer solved the materials problems involved is a good illustration of an effective approach to materials selection.

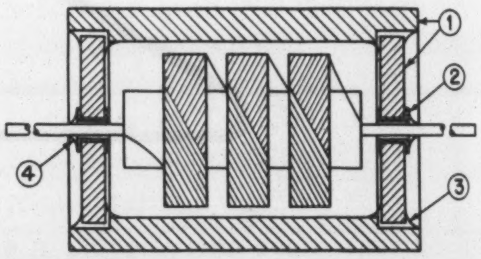
Requirements

Specific requirements insisted upon by the military included: 1) long life and reliability; 2) precision control of electrical parameters; 3) provisions for automatic assembly into printed wiring boards; 4) use of noncorrosive materials; 5) elemination of all bare wires; 6) complete moisture resistance; and 7) nonflammability.

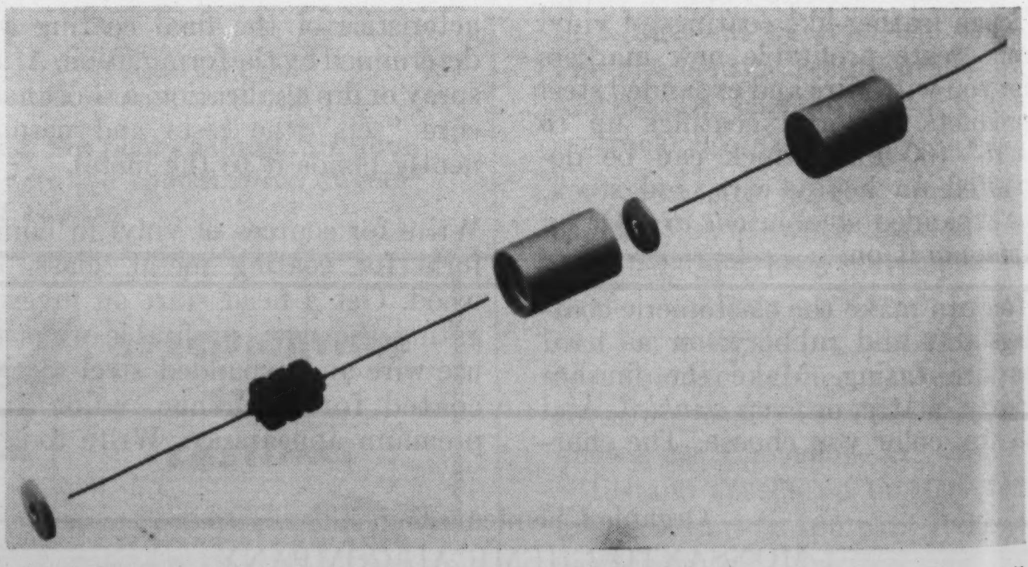
Materials tested

Metal case—The first unit developed was a cadmium-plated brass case with glass end seals; coil lead wires were soldered to eyelets in the glass ends. These units proved ineffective in operation because the proximity of the coil to the metal case resulted in poor frequency response.

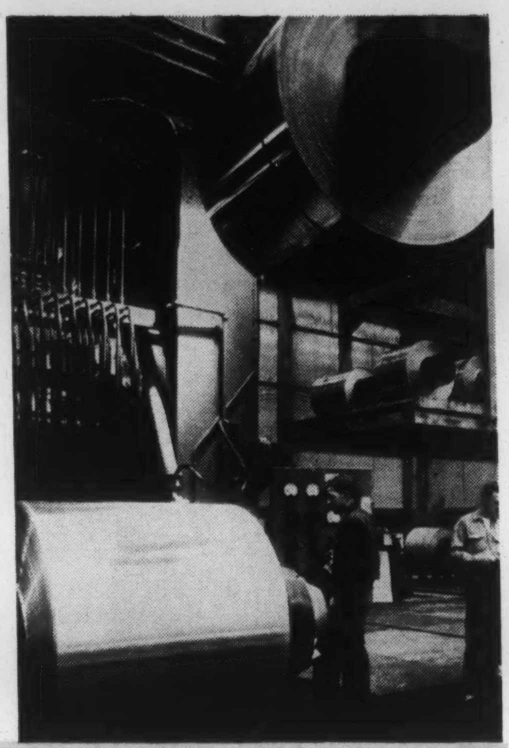
Neoprene case — To eliminate the problem of low frequency response, attempts were made to develop a nonmetallic case that could be hermetically sealed. The best of this type was a cylindrical housing with disc ends, all of neoprene rubber, with phenolic tubes used as dimension stabilizers. Small eyelets for lead wires were assembled into the end plates for the hermetic seal. Although this unit was fairly successful in actual operation, the neoprene was found to be permeable to water; under severe humidity tests, elec-



Cross-section *showing 1) steatite housing, 2) silvered area around end plate holes, 3) epoxy seal and 4) soldered hermetic seal.*



Exploded view *of ceramic-cased coil showing (left to right) end plate, coil, ceramic housing and end plate. Assembled unit is shown at right.*



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FREE CONSULTATION—Let a Riverside-Alloy representative discuss your problems with you. Since 1919, these steel specialists have been available for consultation and advice, without obligation. For the name of your nearest Riverside-Alloy representative, write:
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DESIGN HANDBOOK of Stainless Steel

FOR FREE CATALOG, "Design Handbook of Stainless Steel", write on your letterhead to the address above.

H. K. PORTER COMPANY, INC.
RIVERSIDE-ALLOY METAL DIVISION

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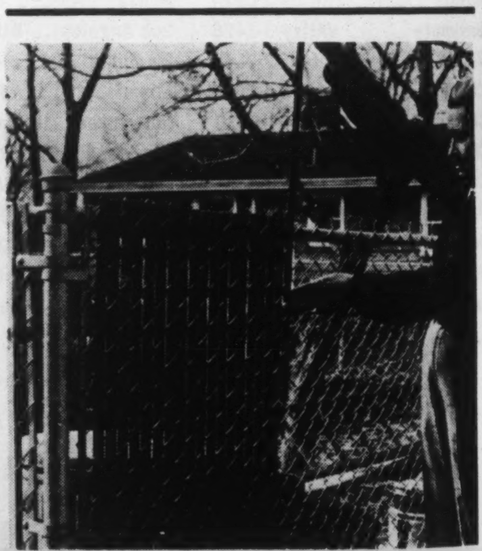
trolysis developed and internal connections were destroyed. In addition, these materials were found to be flammable under severe conditions.

Cast resins—Several cast resin materials were considered but not actually tested because it was felt that they would be too difficult to make nonflammable and because such things as the effect of active hardeners on them were not known.

Ceramics—After having exhausted many other possibilities, Speer decided that a ceramic material might do the trick. Steatite was selected because: 1) it is nonhygroscopic; 2) it is nonflammable; 3) its dimensions can be closely controlled; 4) it has excellent dielectric characteristics; 5) it is inexpensive and nonstrategic; 6) it is non-nutrient to fungus; and 7) silvering techniques and soldering requirements were well known to the company.

However, one further problem remained: previous experience



Inexpensive privacy—An easy and inexpensive way to add privacy to a woven wire fence is shown in the photo above. The simple technique involves nothing more than inserting strips of composition board through the fence openings. The 1 x ⅛-in. strips, manufactured by Masonite Corp., are held in place by friction. They do not have to be painted.

new streamliner program... 2-day Formica shipments

Now you can count on 2-day shipment of standard grades of laminated plastics from the new Formica Streamliner stocks. You'll get faster shipment of all standard grades thanks to new inventories of "treated," or semi-processed materials which have now been set up.
Twenty-five "special purpose" grades—now offered for the first time—offer new design opportunities.

Your additional new grade requirements will be met through expanded research and development facilities now available—including Formica's new resin research laboratories and resin processing plant. Write for free copies of the new Streamliner folder and Stock List-Price List. Formica Corporation, subsidiary of American Cyanamid, 4550 Spring Grove Ave., Cincinnati 32, Ohio.

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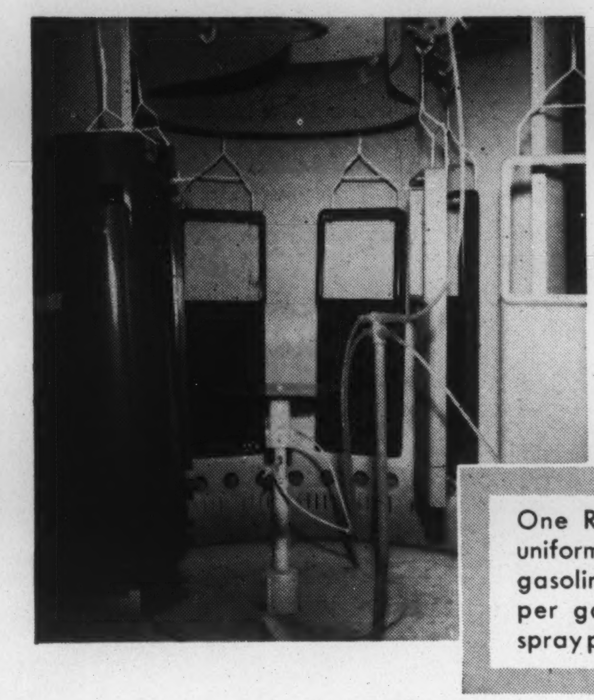
PRODUCTION MORE THAN TRIPLED . . .
PAINT MILEAGE INCREASED 75% WITH



Ransburg
NO. 2
PROCESS

One Ransburg reciprocating disk uniformly coats 7 complete sets of gasoline pump housings and parts per gallon of paint. Former hand spray produced only 4 sets per gallon.

● Bowser, Inc. Fort Wayne Division is continuously on the lookout for improved manufacturing methods in the production of their quality line of gasoline pumps.

That's why they modernized their finishing department . . . installed a conveyor . . . new oven . . . and replaced hand spray with one RANSBURG No. 2 PROCESS reciprocating disk unit.

RESULTS? Paint mileage increased 75% with less labor. With hand spray, they painted enough pump housings and parts for 4 pumps per gallon of paint. Now, with *Electrostatic,* they're painting 7 complete pump sets per gallon.

Where Bowser formerly needed two shifts in finishing, one shift now handles even greater production. With hand spray and limited oven facilities, they used to turn out 15 sets per hour. Now, they can paint 55 sets an hour, either prime or finish. Color changes are made quickly and easily with Ransburg equipment, and because of its efficiency in operation, maintenance cost in the paint area is cut 50%.

NO REASON WHY YOU CAN'T DO IT, TOO!

Whatever your product, if it's painted, we'd like to tell you more about the worthwhile savings and advantages which can be yours with RANSBURG ELECTROSTATIC PAINTING PROCESSES. Write for our No. 2 Process brochure which cites numerous examples of electrostatic spray painting on a wide variety of products.

Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

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with this material indicated that end sealing requires the use of a phenolic or other plastic as an end plug. This obviously could not be done where true hermetic sealing and nonflammability were required. It was decided, therefore, that the assembly using the steatite housing should be similar to the one originally designed; i.e., the housing would be an outside shell only, the coil retained within it, with lead wires protruding through the end plates and soldered to them. The complete housing would then be vacuum filled with a microcrystalline wax.

Final design

The ultimate design was a housing in the form of a ceramic tube with circular end plates fitted into counterbored ends (see photo). Each end plate has a silvered hole through which lead wires of the coil protrude. A spe-

PVC for drippings—To catch icing drippings from cookies as they are carried along on trolleys during the drying process, Sunshine Biscuit Co. uses endless conveyor belts made of polyvinyl chloride. This material is used because it is nonporous and easy to keep clean and sanitary by wiping with a moist cloth. The belts, manufactured by B. F. Goodrich Industrial Products Co., are 38 in. wide and 40 to 56 ft long.

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QUALITY BALLPOINT PEN DEPENDS ON UNIFORMITY OF 8 GRC "MATED" PARTS

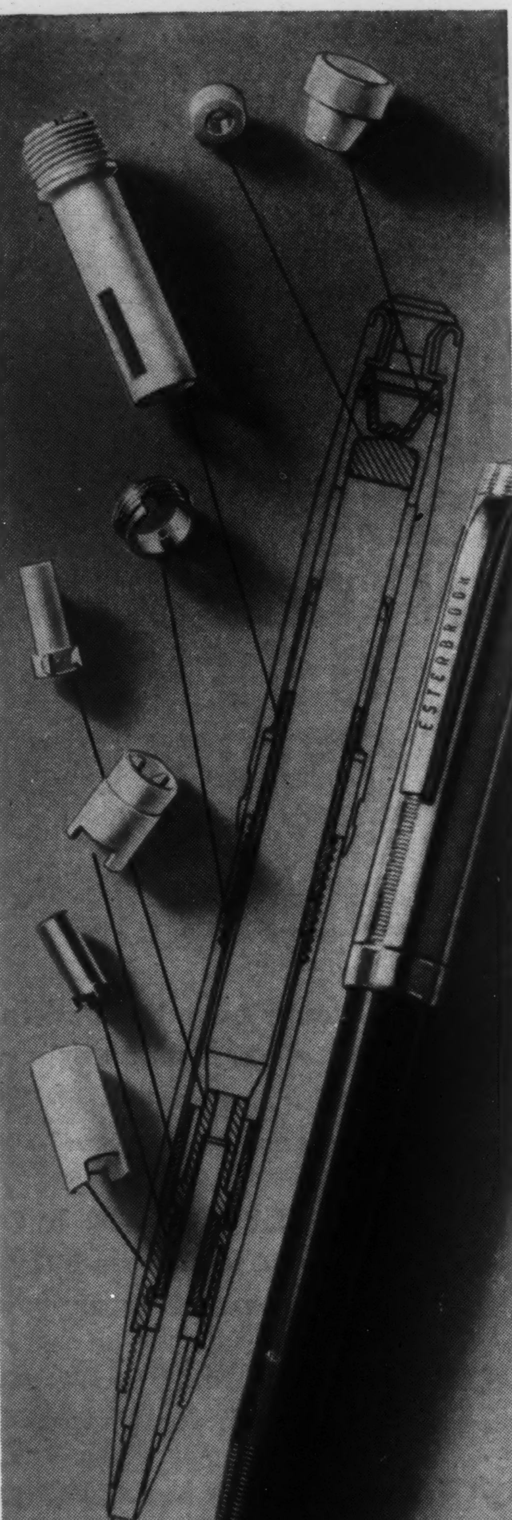
Die Cast and Molded Components Assure Trouble-Free Operation of Esterbrook's New Rotating Mechanism

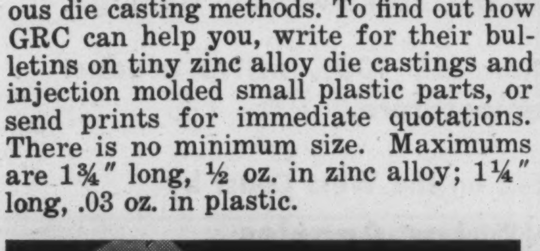
GRC mass-production techniques have again provided a new dimension to designers faced with a difficult situation. Esterbrook engineers, realizing that most people pick up a pen repeatedly the same way, evolved a rotating mechanism to avoid wearing the ballpoint unevenly and to achieve better ink distribution. The intricate mechanism, however, presented a production problem. Parts had to be uniform, durable, meet close tolerances in order to assure proper mating of components and dependable functioning of the assembled pen.

GRC's exclusive, patented methods for the precise automatic production of tiny parts solved the problem, and at lower costs. Gries molded five of the parts in duPont nylon, die cast two others in zinc alloy for strength and greatest economy. The eighth was Gries' nylon counterpart for an originally-scheduled screw machine part, produced for a fraction of the cost and more satisfactorily. These eight parts form the foundation of the mechanism for this new-type pen.

Uniformly accurate, clean, well within critical tolerances, these GRC die cast and molded parts eliminated the necessity of selective assembly and insure trouble-free operation by fitting mating parts exactly. Tests of the pen showed parts worked like new after the equivalent of more than a year's normal use, still worked smoothly after the equivalent of fifty years' hard use. (See illustration at left above.)

This high quality pen is typical of the new designs and cost saving economies possible through Gries' unique single cavity molding techniques and ingenious die casting methods. To find out how GRC can help you, write for their bulletins on tiny zinc alloy die castings and injection molded small plastic parts, or send prints for immediate quotations. There is no minimum size. Maximums are 1¾" long, ½ oz. in zinc alloy; 1¼" long, .03 oz. in plastic.





See GRC at the Design Engineering Show— Booth 850

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.
153 Beechwood Avenue, New Rochelle, New York
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cial epoxy sealing material was developed to cement and plates to the tube. However, the epoxy does not come into contact with the coil wires or residual solder fluxes, and its effect on coil life is negligible.

As a result of this research, development and testing, a hermetically sealed unit was produced that not only satisfied all requirements, but also was relatively independent of unfamiliar materials with undetermined characteristics.

Huge Steel Spikes Halt Earth Movement

In an attempt to prevent dangerous and costly earth slippage, engineers have come up with an ingenious method involving the use of 20-ft long "spikes," or caissons, weighing 22 tons each. The spikes are actually huge cylinders filled with a specially designed steel reinforcing cage and concrete. The 2-ton reinforcing cage consists of two rings of vertical steel bars, the inside ring being staggered to allow a maximum number of bars with a maximum of clearance (see photo No. 1 below).

A spike is made by lowering a

1. Steel cage *is lowered into cylinder prior to pouring of concrete.*

STAINLESS
STEEL
RESISTS
RUST!

Everybody knows that. But it's only *one* reason why stainless is preferred when the design calls for *lasting beauty* and *durability*. Stainless resists chemical corrosion, too — and heat, and denting. It never peels — and its solid beauty comes up bright with just soap-and-water washing. "*Make it better, make it stainless*" is good advice. And the very best stainless steels are made with Vancoram Ferro Alloys! Vanadium Corporation of America, 420 Lexington Ave., N. Y. 17, N. Y. Producers of alloys, metals and chemicals.

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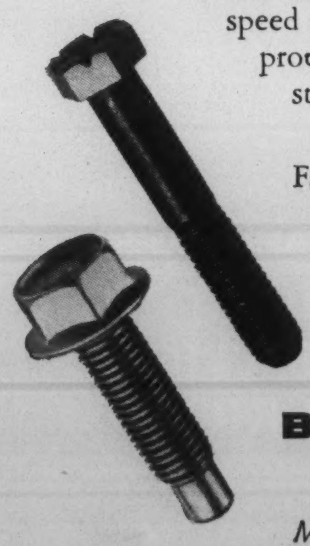

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Fasteners by Buffalo Bolt can help increase the strength and reputation of YOUR products ... be sure to see them at BOOTH 958.

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Making both Fasteners and Friends for 100 years

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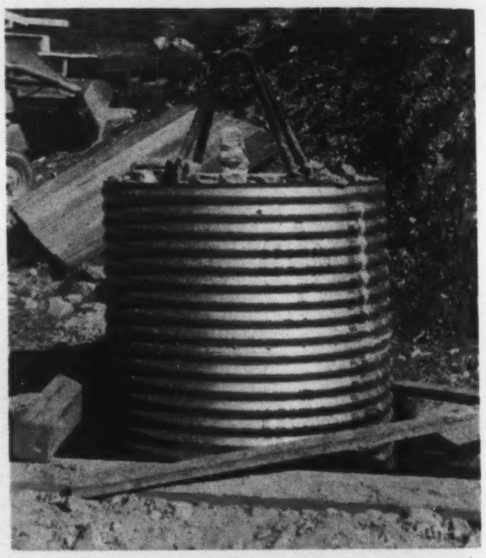
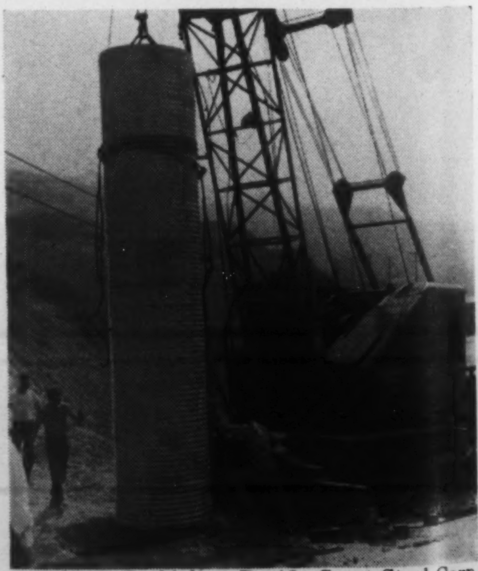
cylinder into a casting hole, inserting the steel cage, and pouring the concrete. After casting, the spike is cured for a week until the concrete reaches a minimum compressive strength of 2000 psi. Then the spike is moved to the placement site where it is lowered to a position across the slip plane at the slide base (see photo 3).

Each spike is said to possess a shear resistance of more than 2,000,000 lb. Fifteen such spikes have reduced earth slippage from 1¼ in. per day to 0.3 in. in one location in Los Angeles. Eventually all slippage is expected to stop.



2. After pouring, *the reinforced concrete spike is allowed to cure for a week.*



All photos Bethlehem Pacific Coast Steel Corp.

3. After curing, *the spike is placed in hole.*

PRICES AND SUPPLY

...AT A GLANCE

CONSUMPTION OF REFINED LEAD IN 1957 WAS THE LOWEST it has been since 1949, according to the American Bureau of Metal Statistics. Total consumption in 1957 amounted to 463,000 tons, or 61,788 tons less than that in 1956. A breakdown of the figures shows that the industry's largest consumer, battery manufacturers, used only 64,761 tons, or approximately 6000 tons less than last year. Cable manufacturers used approximately 22,000 tons less in 1957 than in 1956.

GEOGRAPHIC PRICE DIFFERENTIALS FOR LAMINATED PLASTICS MAY BE ELIMINATED as a result of a recent move by Taylor Fibre Co. The company says it has removed the 2¢-per-lb premium generally charged for West Coast deliveries. The price equalization, first in the industry, is said to apply to sheet, rods and tubes, and to the materials costs of fabricated products.

A BILL TO RAISE THE COPPER 'PERIL POINT' was recently introduced before Congress. Provisions of the bill call for a 4¢ per lb import tax and an increase in the peril point from 24¢ to 30¢ per lb. The present import tax of approximately 2¢ per lb, effective only when the domestic price falls below 24¢ per lb for a calendar month, has not been applied since the Korean War. According to Phelps Dodge, foreign copper imports represent a "threat to the economy when the price falls below 30¢ per lb." The bill is sponsored by 14 Senators and 13 Congressmen.

ALUMINUM PRODUCTION WAS 38,000 TONS LOWER IN 1957 than in 1956. Nevertheless, it was the third successive year in which primary aluminum production totaled more than 1½ billion tons. Prospect for 1958 is that there will be enough aluminum available to satisfy all demands.

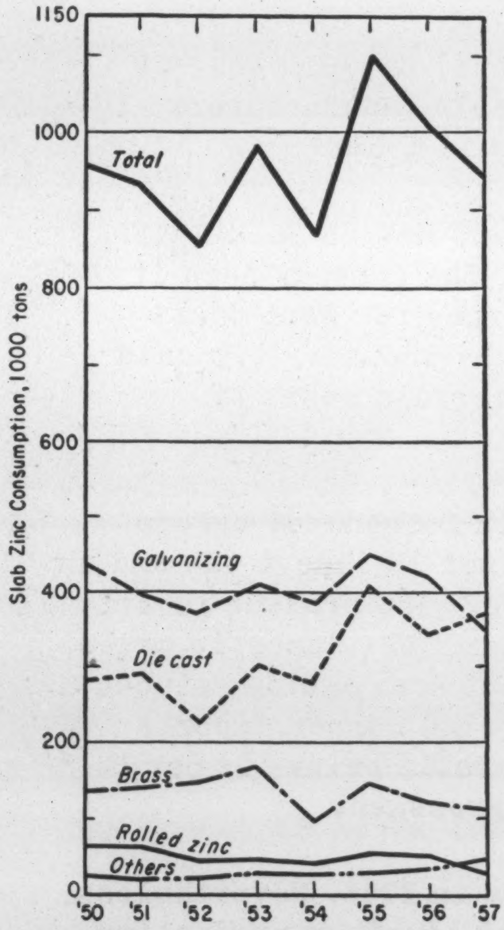
INCREASED PRODUCTION OF ALUMINUM IN 1958 is slated by Reynolds Metals Co. as a result of three new potlines scheduled to go into service this summer. Total new rated capacity is estimated at 112,500 tons per year. The increase will bring Reynolds' total capacity to 190,000 tons per year.

TONNAGE QUANTITIES OF A NEW MAN-MADE 'NATURAL' RUBBER are available from Goodyear Tire & Rubber Co. The new material, said to be a "synthetic

◂ For more information, circle No. 553

rubber which has the molecular structure and performance characteristics of the natural tree-grown product," will be produced at an annual rate of 25-30,000 tons.

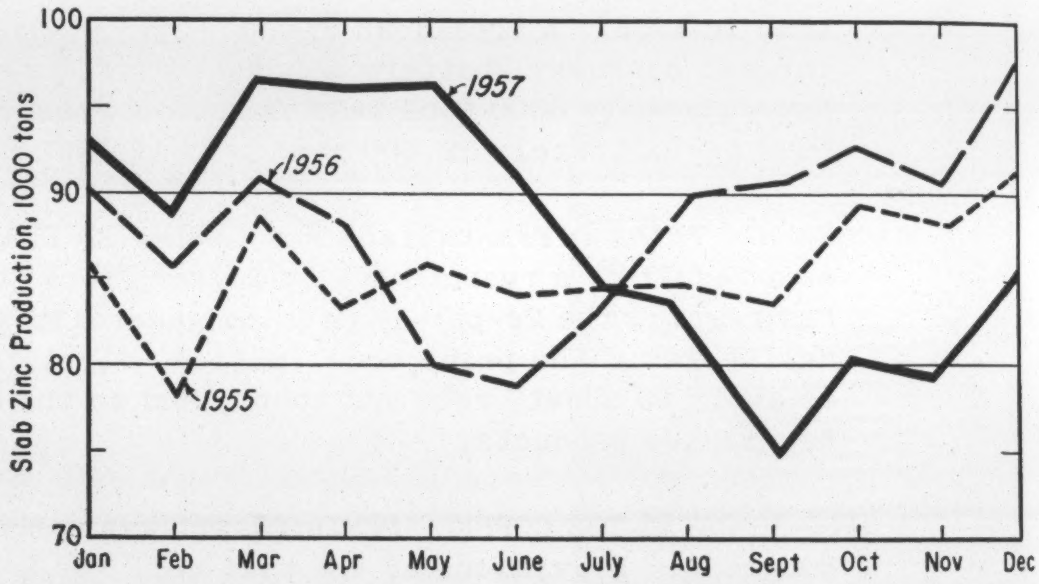
PRICE OF DOUGLAS FIR PLYWOOD IS NOW DOWN to $64 per 1000 ft. In early February it was selling for $66 and in January it was $72. The decreases have come in spite of the fact that consumption is 10% higher this year than it was at this time last year. However, consumption is still 10% lower than production, which is running at only 84% of capacity.



Consumption of slab zinc *by industry from 1950 to 1957.*

Prices of Materials

The price tables which have been published on the opposite page every month for the past year will now be published quarterly. They will appear next in the June issue.



Both charts based on American Zinc Institute figures.

Comparison of zinc production *over the last three years.*

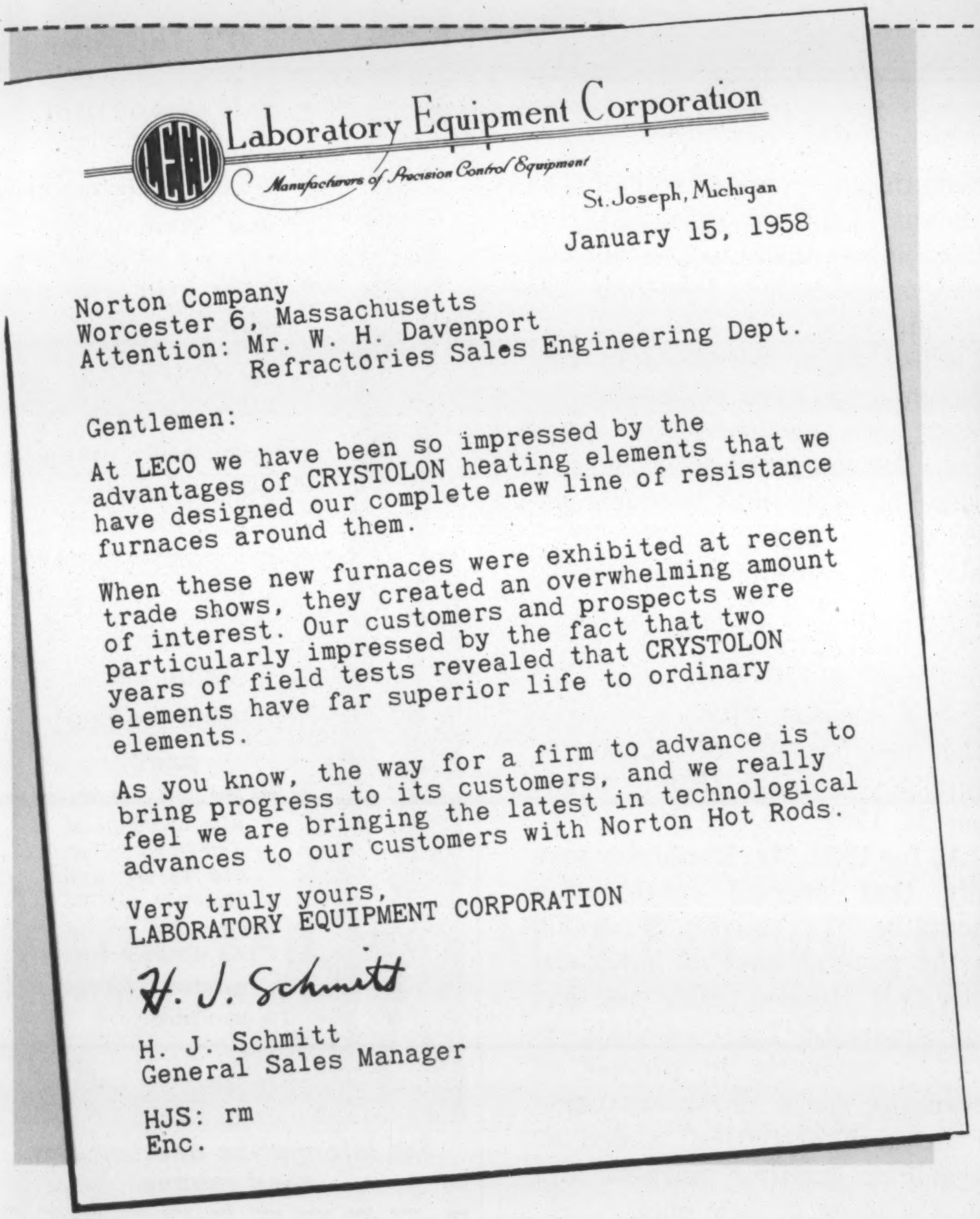
Zinc Production High in '57; Consumption Down Slightly

■ Domestic production of slab zinc during 1957 amounted to 1,057,000 tons — approximately 6000 tons lower than the all-time high of 1,063,000 tons produced during 1956, and 28,000 tons higher than the previous high of 1,029,000 tons produced during 1955. Consumption of zinc, however, was 7% lower in 1957 than it was in 1956—936,000 tons as compared to 1,009,000 tons. In spite of this, John L. Kimberley, executive vice president of the American Zinc Institute, says that the pattern in 1957 varied only slightly from that of previous years (see accompanying graph).

According to Mr. Kimberley, the most significant difference between 1957 and other years is the fact that for the first time consumption of zinc for die castings exceeded that consumed by the galvanizing industry. The amount of zinc used for die castings actually totaled 371,000 tons, or approximately 11,000 tons

Leco designs new furnaces around Norton "HOT RODS"

Leading lab furnace builder reports longer life and other advantages of CRYSTOLON heating elements*



Laboratory Equipment Corporation
Manufacturers of Precision Control Equipment
St. Joseph, Michigan

January 15, 1958

Norton Company
Worcester 6, Massachusetts
Attention: Mr. W. H. Davenport
Refractories Sales Engineering Dept.

Gentlemen:

At LECO we have been so impressed by the advantages of CRYSTOLON heating elements that we have designed our complete new line of resistance furnaces around them.

When these new furnaces were exhibited at recent trade shows, they created an overwhelming amount of interest. Our customers and prospects were particularly impressed by the fact that two years of field tests revealed that CRYSTOLON elements have far superior life to ordinary elements.

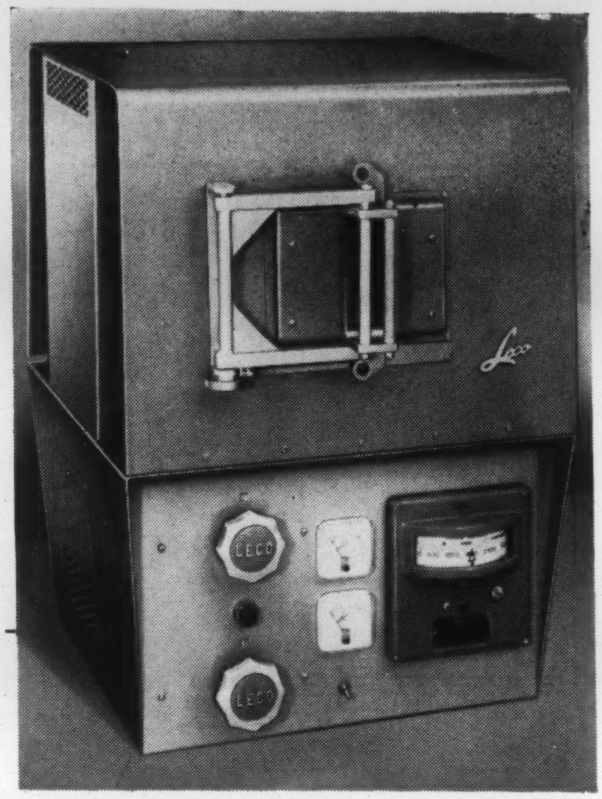
As you know, the way for a firm to advance is to bring progress to its customers, and we really feel we are bringing the latest in technological advances to our customers with Norton Hot Rods.

Very truly yours,
LABORATORY EQUIPMENT CORPORATION

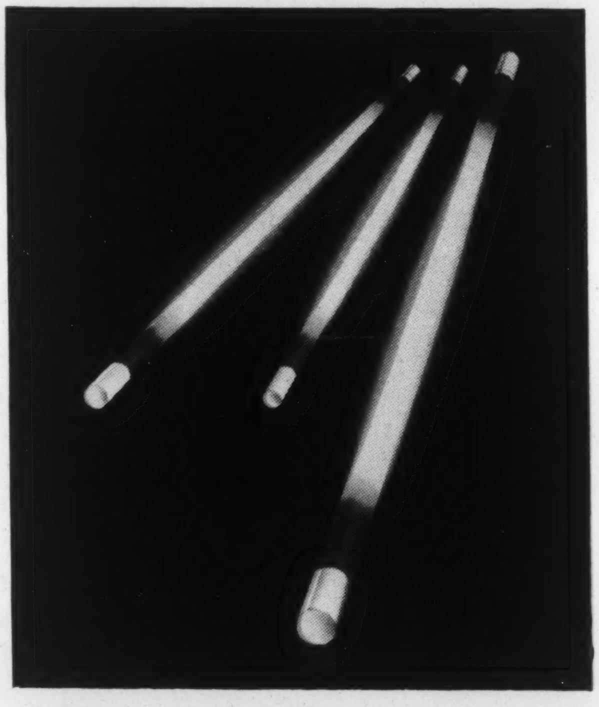
H. J. Schmitt

H. J. Schmitt
General Sales Manager

HJS: rm
Enc.



The new LECO Model 542 Box Furnace — equipped with long-life CRYSTOLON heating elements — is shown above. Other new Hot Rod-equipped LECO furnaces include two tube and four tube models.



CRYSTOLON Heating Elements, or "Hot Rods", are a typical Norton ℞ — an expertly engineered refractory prescription for greater efficiency and economy in electric furnace and kiln operations. Made of self-bonded silicon carbide, each one-piece rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes.

Similar reports from many other plants mean that you, too, can save with "Hot Rods" because their extra long life greatly reduces replacements. Also, you get reduced maintenance due to less changing of elements and voltage taps. One-piece, non-welded "Hot Rods" are strong and straight . . . help protect product quality because their slow, evenly matched rate of resistance provides more uniform heating quality . . . and they are packed shockproof to reach you unbroken. For further facts send for booklet *Norton Heating Elements*. NORTON COMPANY, Refractories Division, 343 New Bond Street, Worcester 6, Massachusetts.

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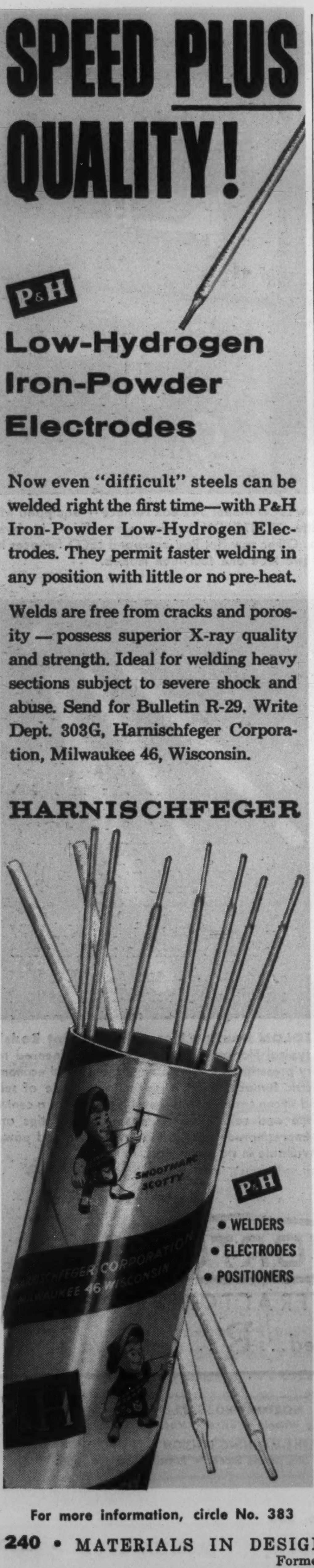
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SLAB ZINC CONSUMPTION
(1000 Tons)[a]

End Use ↓	1955	1956	1957
Brass Products	146	121	112
Galvanizing	451	439	363
Rolled Zinc	52	47	41
Zinc-Base Alloys	431	360	371
Zinc Oxide, Others	40	37	49
Total	1120	1004	936

[a] Based on American Zinc Institute figures.

more than were used in 1956. The amount of zinc used in 1957 for galvanizing amounted to 363,000 tons, or about 17% less than that used in 1956.

Other major decreases in zinc consumption were registered for brass mill products and rolled zinc. As compared to 1956, zinc usage in brass mill products decreased by approximately 10%; rolled zinc consumption was down 13%.

On the other side of the scale, consumption of slab zinc for French process zinc oxide and other uses showed an increase of from 38,000 tons in 1956 to 49,000 tons in 1957.

As for 1958, Mr. Kimberley says only that over-all consumption should be "... essentially parallel to the general level of industrial activity." He also points out that the American Zinc Institute is "... currently in process of arranging for a major expansion in research activities" aimed at expanding existing markets and the discovery of new ones.

Aluminum in Boats, Cars To Be Highest in 1958

Although over-all use of aluminum was less in 1957 than in 1956, and the outlook for 1958 is about the same, at least two areas of consumption—cars and boats—should show increases this year.

(continued on p 242)

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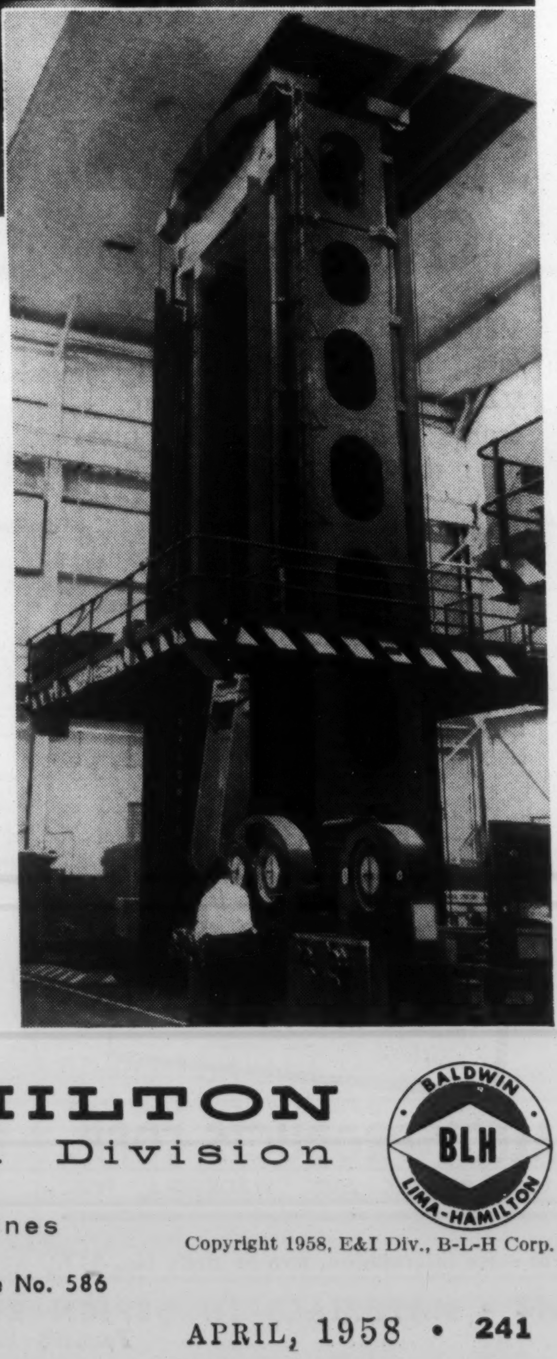

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PRICES AND SUPPLY

Aluminum—continued from p 240

Automobiles

According to Kaiser Aluminum & Chemical Sales, Inc., use of aluminum in 1958 model automobiles will be 13% greater than it was last year and more than 80% greater than it was in 1955. The average amount of aluminum used in the new models is 44.9 lb as compared with 39.6 lb in 1957 and 24.8 lb in 1955 (see accompanying table).

Specific areas where aluminum usage has increased include grilles, brake drums, automatic transmissions and power assist units. General Motors' automobiles reveal the largest gain with an average increase per car of 30%—from 32 to 41.6 lb. The most aluminum, 119 lb, is used in Chrysler Corp.'s Imperial line.

Automotive consumption of aluminum mill products in 1958 is expected to show an increase of 8% in castings and 53% in wrought products such as extrusions and sheet.

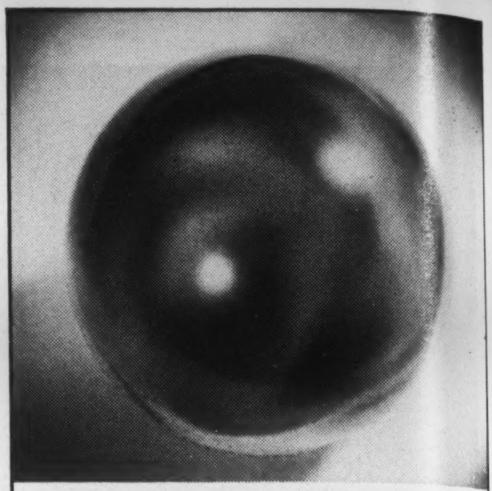
Small boats

According to Aluminum Co. of America, outboard craft made of colored aluminum "will dominate the small boat market in the near future." This prediction was based on a recent survey of the small boat industry.

In the survey, Alcoa questioned 32 of the nation's aluminum boat manufacturers and 32 plastics and wood boat manufacturers. The study is claimed to have estab-

WEIGHT OF ALUMINUM PER CAR—1957 VS 1958 (lb)

Company ↓	1957	1958	Increase, %
General Motors Corp.	32.0	41.6	30
Ford Motor Co.	35.7	39.6	11
Chrysler Corp.	65.2	63.3	-3
American Motor Sales Corp.	48.8	48.8	0
Studebaker-Packard Corp.	22.6	22.6	0
Total	39.6	44.9	13



ROTATIONAL CASTING

Among the many new Reynosol processing methods is rotational casting—formulating toys, play balls, squeeze bottles, and novelties. Although to the plastisol field, rotational casting is a rather new development, Reynolds extensive experience and source-of-supply contacts are available upon direct request.

GENERAL SPECIFICATIONS	
COLOR	Unlimited
COST	Competitive with rubber
WEIGHT	Sp. gr. = 1.20 or 10 lb. per gal.
TOXICITY	Can be formulated to be non-toxic
AGING PROPERTIES	Good
COLD PROPERTIES	Flexible at —65° F.
LIGHT RESISTANCE	Good
TYPE OF SURFACE	Dry and glossy
TENSILE STRENGTH	Very good (as high as 1800 psi)
SCUFF RESISTANCE	Very good
ABRASION RESISTANCE	Very good
ALKALI RESISTANCE	Very good
ACID RESISTANCE	Very good
OIL RESISTANCE	Very good
HARDNESS	As high as 95 (Shore A)
FIRE HAZARD	None

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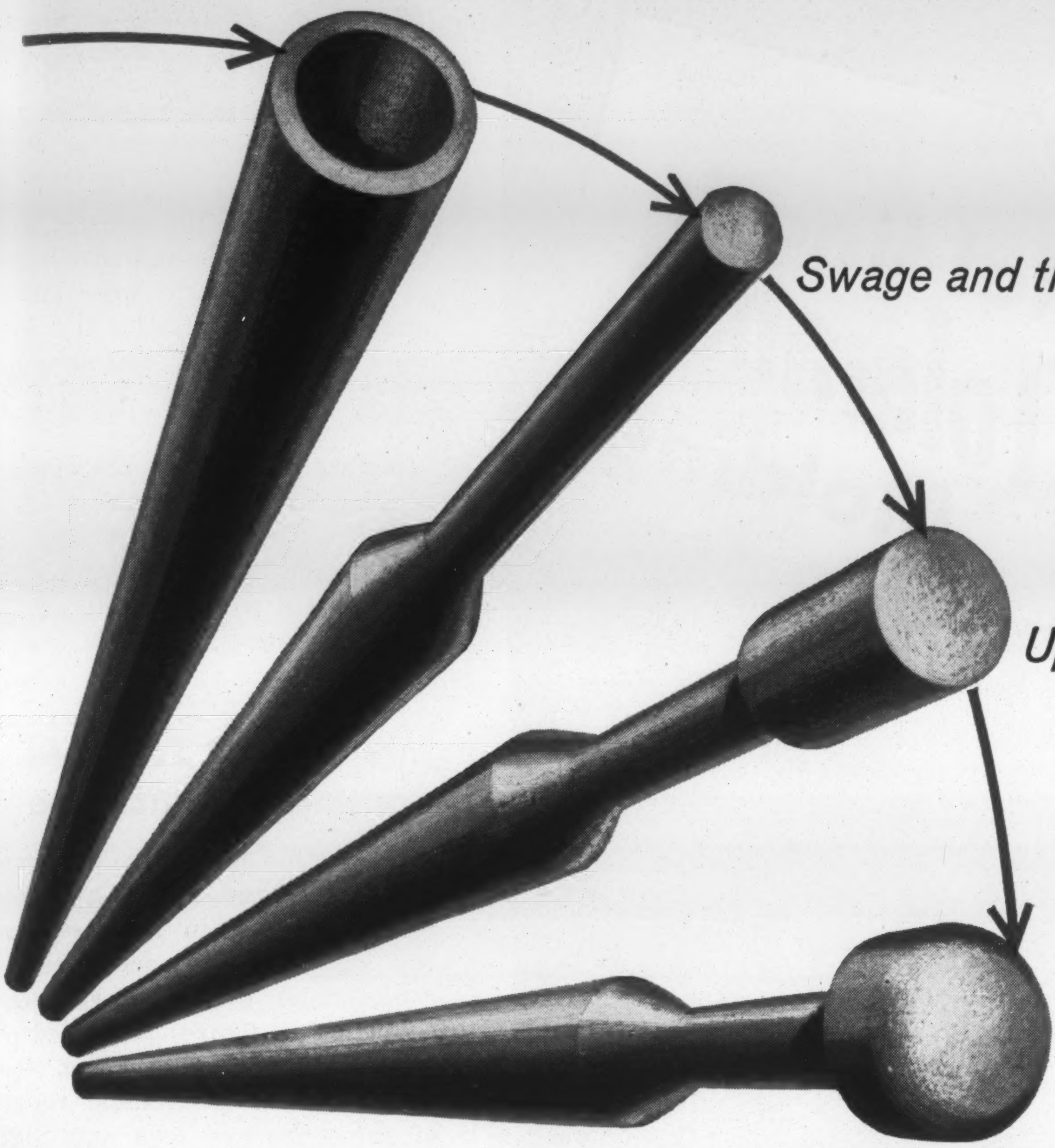
Start with OSTUCO TUBING



and end up with a **34%** *saving*

Here's a cost-cutting case history right in the Ohio Seamless mill. It proves we take our own medicine—*and like it.* You may, too.

Formerly, mandrels for rolling Ostuco Tubing on our Assel mill were made from two pieces. A shaped end, hogged out of solid bar stock, was welded to a long tube. Expensive to machine, weld and process.

We decided to *forge the mandrels entirely from Ostuco Seamless Steel Tubing.* In three steps—swage, upset and finish-form—we now produce better mandrels . . . ready for use without any machining whatsoever, *and save 34% over former processing methods.*

Chances are good that Ostuco Tubing is the right prescription for slashing your production costs, too. For expert advice, contact our nearest sales office or our plant at *Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.*

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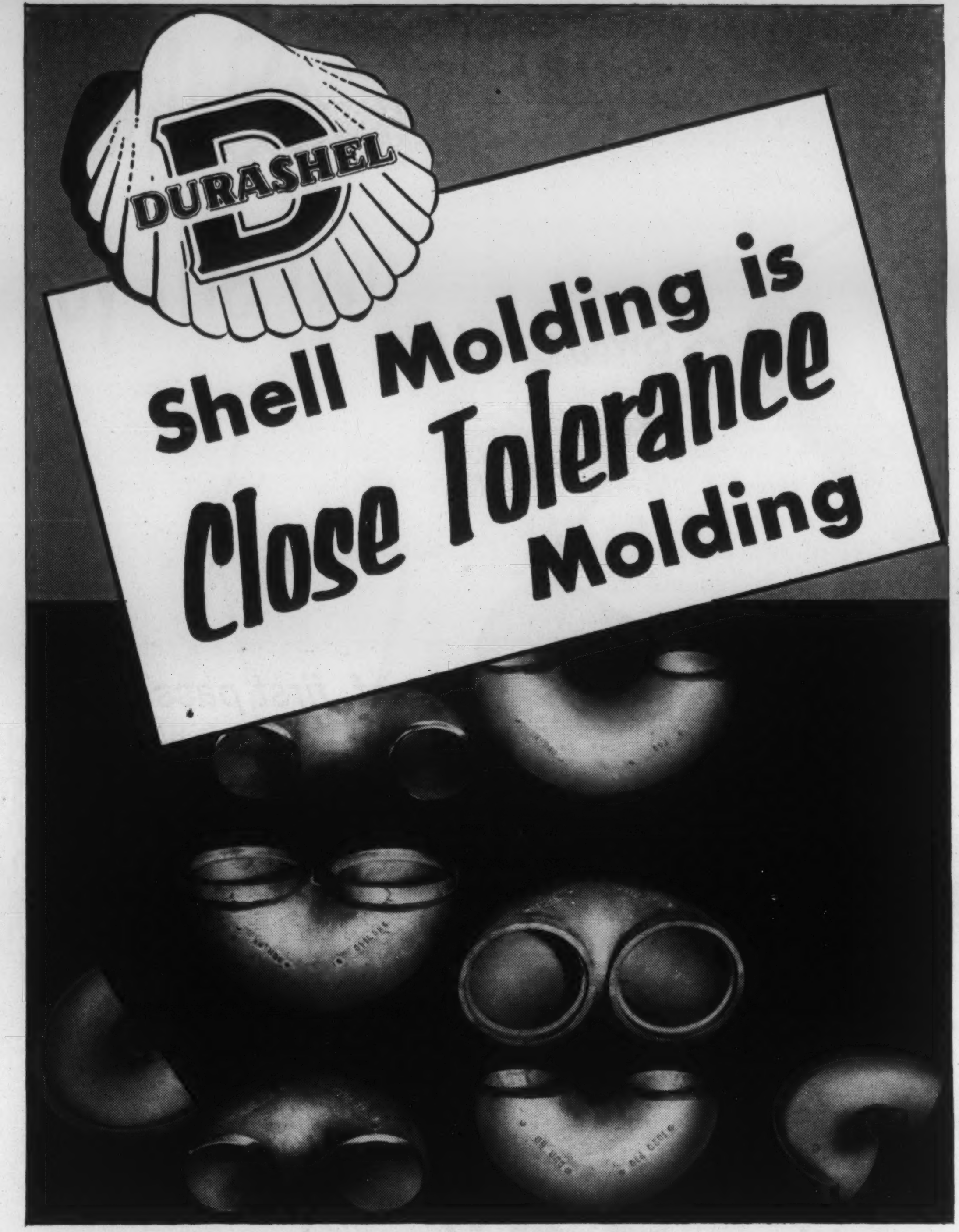

These are Duraloy Shell Molded 180° Bends. And incidentally, several different alloying combinations of chrome iron and nickel are represented in these bends.

One of the outstanding values in shell molded castings is the higher precision or close tolerance casting . . . also usually less machining and finishing . . . than when pieces are cast statically. For quantity production it is usually more economical.

We suggest that you investigate shell molding for your high alloy casting requirements. It has much to offer and we have complete facilities for taking care of your requirements. Should other casting methods—static or centrifugal be better, we have these facilities, too.

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lished that, of the 400,000 outboard boats made and sold in the U. S. in 1956, 22% were aluminum, 22% were plastics and 46% were wood. In 1957, 460,000 small boats were sold, of which 33% were aluminum.

According to Alcoa, the number of aluminum boats sold in 1961 will rise to 210,000, or a 63% increase over 1956. Aluminum's expected gain will be made at the expense of wood.

Use of '200' Stainless Continues to Increase

Production and use of chromium-manganese-nickel stainless steel continued to increase during 1957 despite decreases in other major groups of stainless, according to figures published on stainless and heat resisting steel production in the annual report of the American Iron and Steel Institute.

According to the report, total production of the two new types (201 and 202) amounted to 25,330 net tons—an increase over 1956 of nearly 6000 tons. Total ingot production of all types of stainless and heat resisting steels reached just over a million tons—a decrease of 210,000 tons as compared to the record high of 1,210,569 tons produced during 1956.

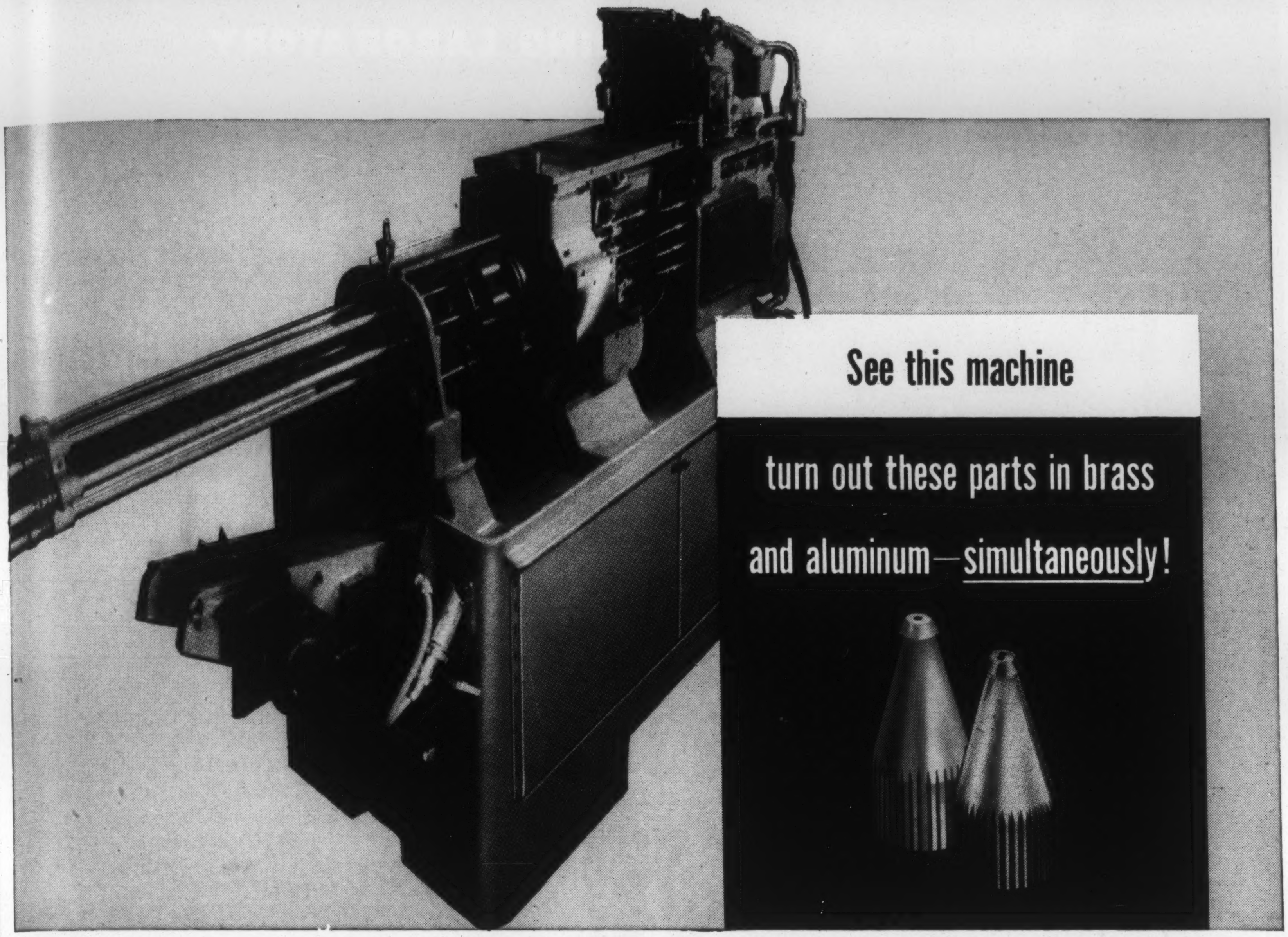
By far the greatest single reduction in stainless production was registered for the 300 series (nickel-chromium).

In 1956 production of manganese-nickel stainless amounted to 19,390 tons; in 1955, production was only 1886 tons.

USE THE 'SELECTOR'—You will find properties of most engineering materials, plus names and addresses of suppliers, in M/DE's *Materials Selector* reference issue, published last September.

BETTER MACHINING STARTS WITH ALCOA SCREW MACHINE STOCK

Alcoa proved it in Cleveland . . . now will prove it in other cities



See screw machine parts produced in aluminum at less cost than steel or brass

When Alcoa and National Acme Company sponsored a machining demonstration in Cleveland last September, 700 design and production engineers and purchasing people saw aluminum and brass parts produced *simultaneously* on a six-spindle automatic screw machine—saw documented evidence that screw machine parts can be produced cheaper in aluminum than in brass or steel. Many expressed frank amazement at the cost comparisons shown.

Here is eye-opening machining news for all industry. Now *you* can see this demonstration, which Alcoa will sponsor in Chicago, Boston, New York*, Detroit, Los Angeles and other important centers.

If your function is design or production of products that use screw machine parts, you will find the Alcoa machining demonstration an enlightening experience. You will see how aluminum offers the ultimate in design freedom because it's so workable, so easy to machine—because it gives better finishes including anodized color. You will see the new color movie about Alcoa Screw Machine Stock, "The Four Amazing Alloys."

Send in the coupon for your invitation—and for a Design Calculator (slip-stick) for use with Alcoa® Aluminum Screw Machine Stock.

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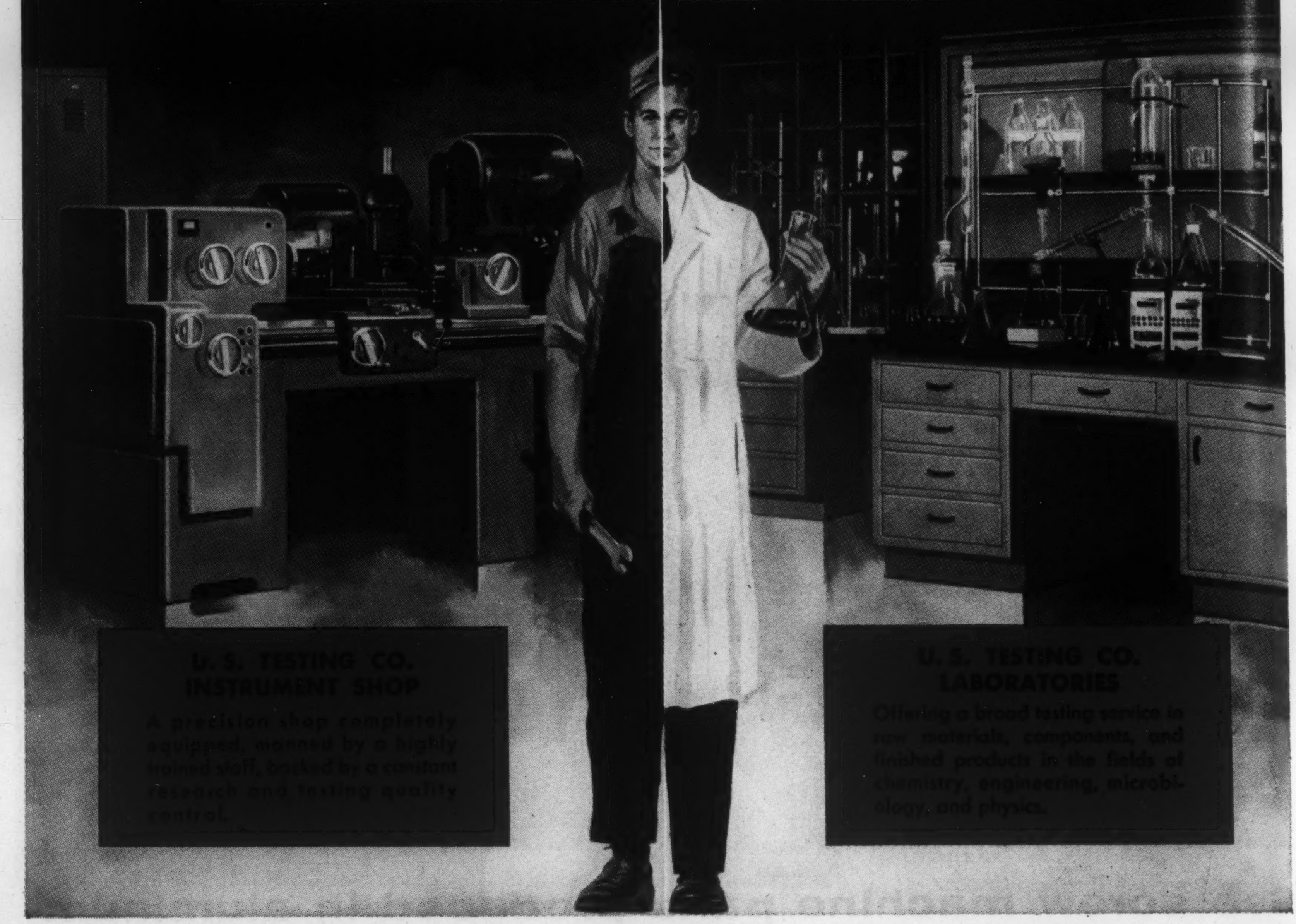
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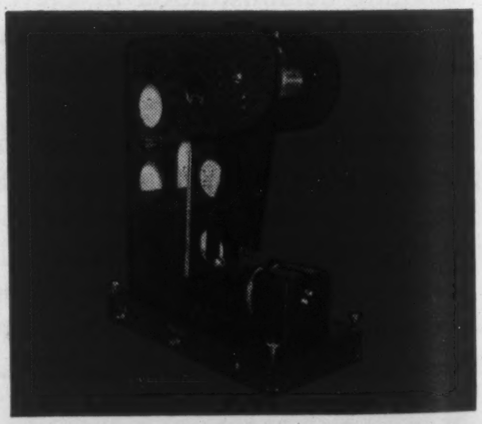

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News OF INDUSTRY

Steel by new process—The photo above shows hot metal transported from the blast furnace being charged directly into a basic oxygen furnace—one stage of Jones & Laughlin Steel Corp.'s new basic oxygen method of producing steel. After the charge is placed, a water-cooled lance is lowered to a pre-determined position above the surface of the molten metal. A jet of high-purity oxygen from the tip of the lance is then directed vertically at the surface of the molten bath, initiating the thermo-chemical reactions that refine the iron into steel.

According to Jones & Laughlin, this method not only produces higher quality steel (low in nitrogen, phosphorus and sulfur), but it does so at much lower cost than other methods. The oxygen steelmaking process was first used in this country by McLouth Steel Corp. several years ago.

Two Big Shows This Month

▸The 3rd Annual Design Engineering Conference, sponsored by the Machine Design Div. of the American Society of Mechanical Engineers, will be held Apr 14-17 at the International Amphitheatre, Chicago. The 3rd Design Show will be held in conjunction with the Conference. (See page 21 for complete program, list of exhibitors and details of registration.)

▸The 14th Annual Meeting of the Metal Powder Assn. will be held Apr 21-23 at the New Sheraton Hotel, Philadelphia. The 1958 Powder Metallurgy Show will be held in conjunction with the meeting. (See page 165 for complete program, list of exhibitors and details of registration.)

Both expositions are expected to surpass last year's successful shows. According to MPA, this year's show will be the largest ever held, attracting at least one-and-a-half times as many exhibitors as were present last year. The Design Show will be at least 10% larger than it was last year.

Tool Engineers Set for May Convention

"Tooling For Competition" is the theme around which the American Society of Tool Engineers' 26th Annual Convention and Tool Show has been planned. The Show will be held May 1-8 at the Philadelphia Convention Center.

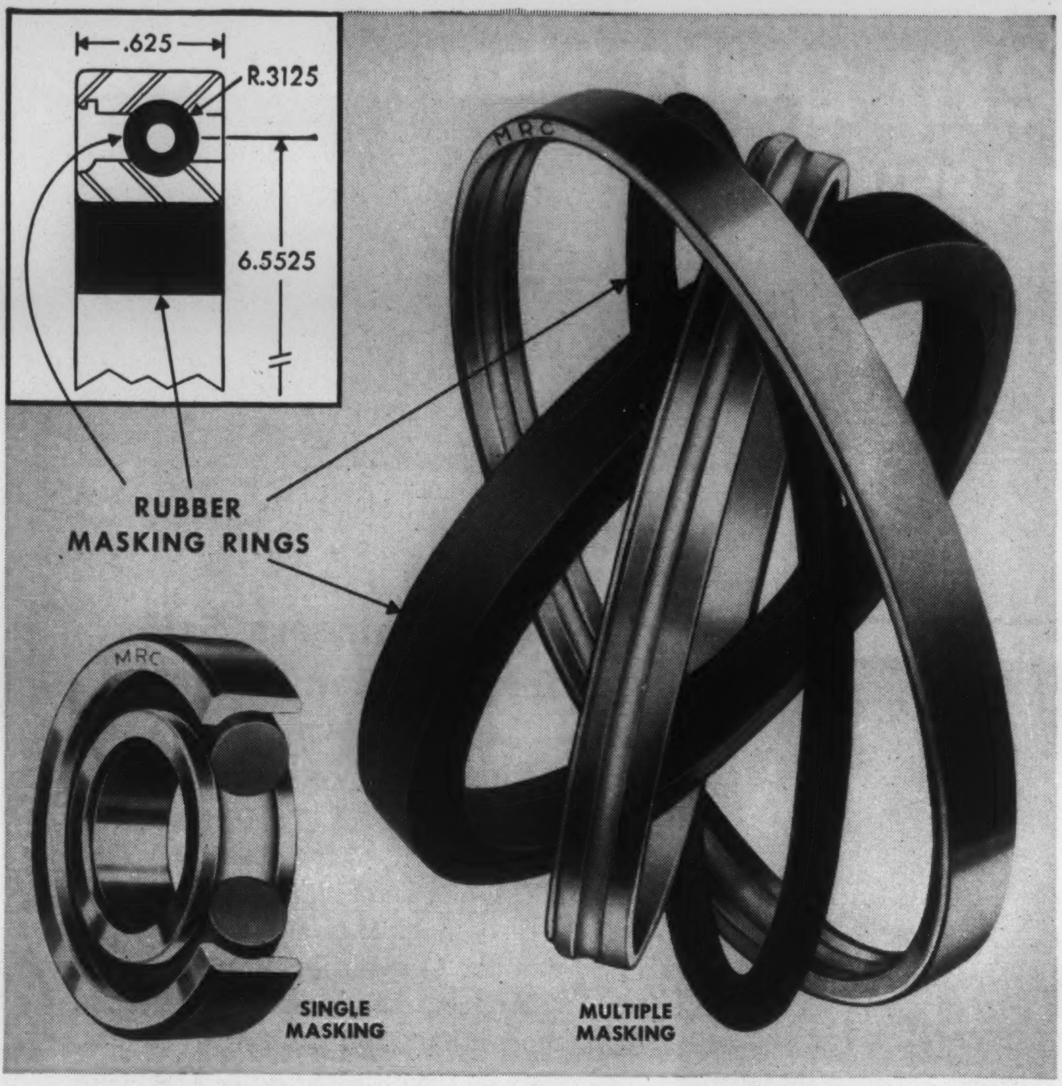
Approximately 500 exhibits and more than 100 technical papers, panels, seminars and symposia have been scheduled for the seven day exposition. Of special interest will be the sessions devoted to automation, numerical control, powder metallurgy, metal cutting, nuclear tooling, European progress and guided missile production.

Typical of the papers scheduled for presentation are: "Microstructure as It Affects Machinability," "Application of Epoxy-Fiber Tools and Dies" and "Basic Developments in Carbide Tooling."

The Show will be open from 9 a.m. to 6 p.m. daily, except Sunday. For further information, contact Richard Gebers, Public Relations Manager, American Society of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.

Du Pont Gets Patent on Linear Polyethylene

A complicated series of legal battles may result from a somewhat belated decision by the U. S. Government Patent Office to grant E. I. du Pont de Nemours & Co. a patent covering linear polyethylene "as a composition of matter"



Photos courtesy Marlin-Rockwell Corp., Jamestown, N. Y.

Rubber Rings Mask Bearings during Plating Process

Here's a new way to mask out plating on bearing race grooves without tedious hand-labor. Regardless of bearing size, rubber rings are fitted precisely into ball grooves and inner ring bore so that plating can't sneak under the rubber even in torturous electroplating baths. Clean division lines always result. Inner ring and outer ring are held together so both can be plated simultaneously. This saves one complete plating cycle. And, this fast assembly prepares bearings for plating in seconds—eliminates costly hand-painting with unreliable stop-off lacquer.

These rubber rings are the result of Marlin-Rockwell Corporation (Jamestown, New York) consulting Continental to solve an important masking problem. Creative engineering successfully developed these extruded and spliced, or molded rubber rings which increased production 2000%—20 times faster than hand-painting. What's more, the special rubber compound withstands repeated baths in blistering acids and caustics without affecting precise dimensions, elasticity or resilience.

This rubber ring technique is typical of the thinking and ingenuity behind rubber parts by Continental. It also represents the economy and better end results accomplished by consulting a rubber specialist *during the planning stage* of a product. If you need help like this, call or write Continental —rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

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regardless of how it is made.

According to Du Pont, the patent grant was based on its discovery of linear (high density) polyethylene more than ten years ago as part of the company's fundamental research program. This patent is only one of a group of ethylene polymerization patents applied for during the years 1947-1951 and only recently granted. According to Robert L Hershey, general manager of the Polychemicals Dept., linear polyethylene has been a "clearly specified" objective of Du Pont research since the middle 1930's.

Du Pont has taken the position, therefore, that it is the only company entitled to license the manufacture of the new material and it has notified other producers that it is offering licenses. Among the companies now producing high density polyethylene are Celanese Corp. of America, Phillips Chemical Co., Hercules Powder Co. and W. R. Grace & Co. Others whose plants are in construction or are approaching production include Union Carbide Corp., Koppers Co. and Dow Chemical Co. Union Carbide has licenses from both Phillips and Karl Ziegler. The Ziegler process is also licensed to Koppers, Hercules, Dow and Du Pont itself. Celanese and Grace hold Phillips' licenses. In addition, a process developed by Standard Oil Co. (Indiana) has been licensed to Eastman Kodak Co. and Spencer Chemical Co.

The patent grant has resulted in some pretty confusing conjectures on the part of competing producers and the consensus seems to be, "Right now we don't know just where we stand," as one of the major producers remarked. Whether Du Pont's assertion will result in legal battles against companies making the high density polyethylene is merely a matter of further conjecture. Most competing companies, however, have taken the position of

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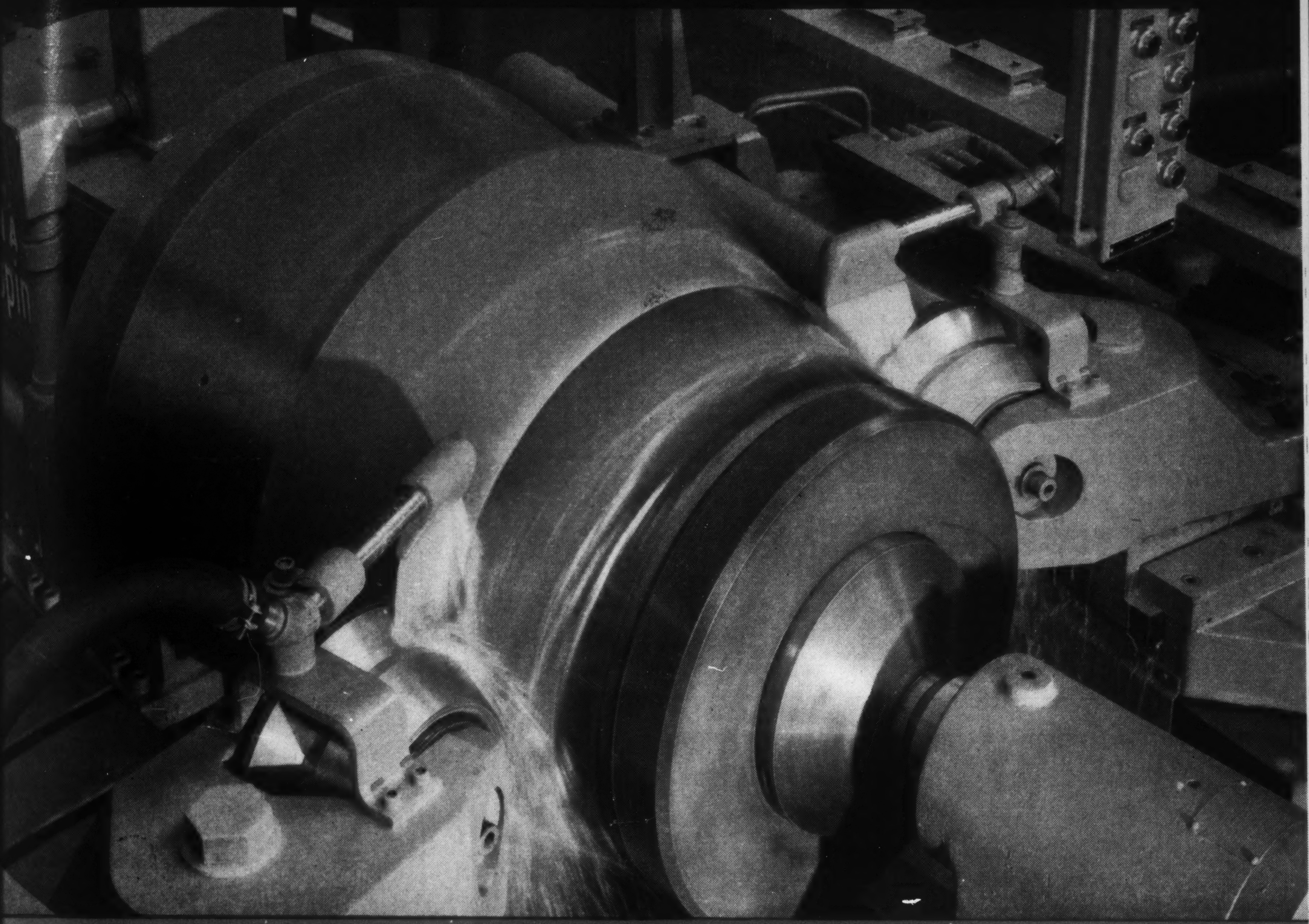

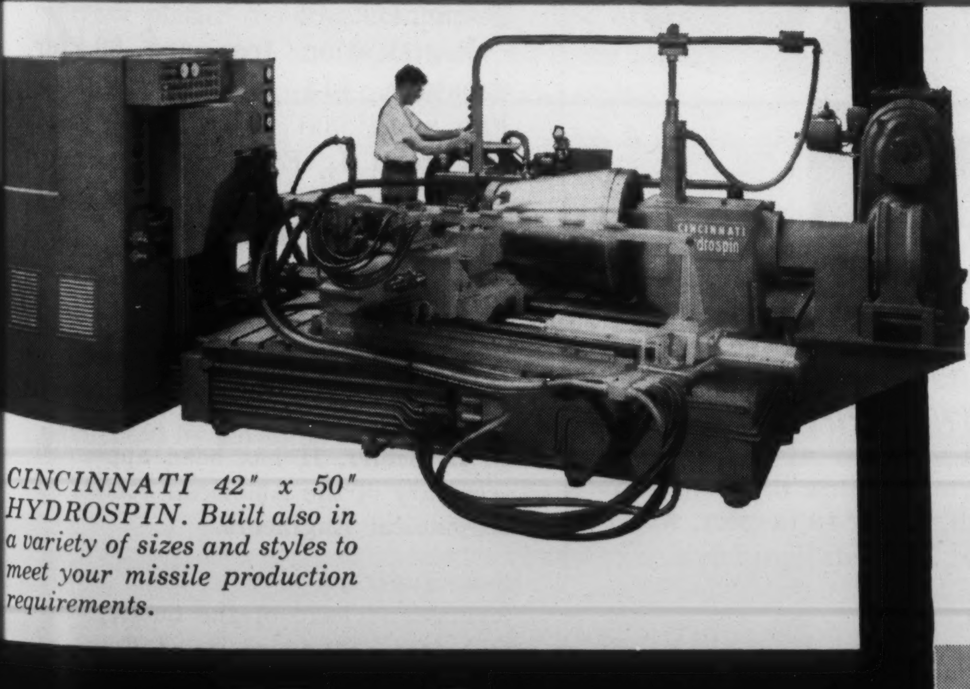

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In developing rocket and missile components, the Cincinnati Hydrospin® can save valuable time and materials in the production of prototype parts. Equally important, the desired part characteristics of high strength, accuracy and fine finish are readily obtainable by Hydrospinning.

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Hydrospin

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CINCINNATI 9, OHIO, U. S. A.

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*Product Development by William M. Schmidt Associates.

H & K perforated metals serve a function of design

The orientation of television, AM-FM radio and phonographic elements into one modular housing containing all mechanical, electronic and control devices is one function of the mock-up illustrated. Another is the utilization of H & K perforated metal for the necessary ventilation and sound requirements of such equipment.

H & K Perforated Metal offers the Industrial Designer and other men of ideas, materials that are aesthetically interesting and functionally honest. If perforated materials can be utilized in your product, please contact us. Our sales engineers will be pleased to work with you.

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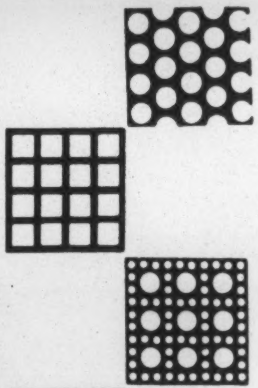
A few of the thousands of H & K patterns are illustrated in reduced size



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BUSADA BUTYRATE PIPE AND FITTINGS

First choice of many of the nation's leading firms because it's easier to install, easier to inspect, won't corrode . . . speeds liquid flow.

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"no further comment" until they have a chance to study the patent ruling in greater detail.

Present production capacity of high density polyethylene is estimated to be 180 million pounds per year. By the end of 1958 this figure is expected to rise to 230 million pounds, and by 1960 to at least 500 million pounds.

Electrochemical Society to Meet Apr 27-May 1

The 113th semi-annual meeting of the Electrochemical Society will be held April 27 to May 1 at the Hotel Statler, New York. Over 150 papers have been scheduled for presentation by the Society's five divisions: Electric Insulation Div., Electronics Div., Electrothermics and Metallurgy Div., Industrial Electrolytic Div. and Theoretical Electrochemical Div.

Highlights of the meeting will be symposia on stress corrosion cracking of stainless steels, high purity metals, semiconductor materials, fused salt electrolysis, ceramics, plastics insulation, printed circuits and electrokinetic phenomena.

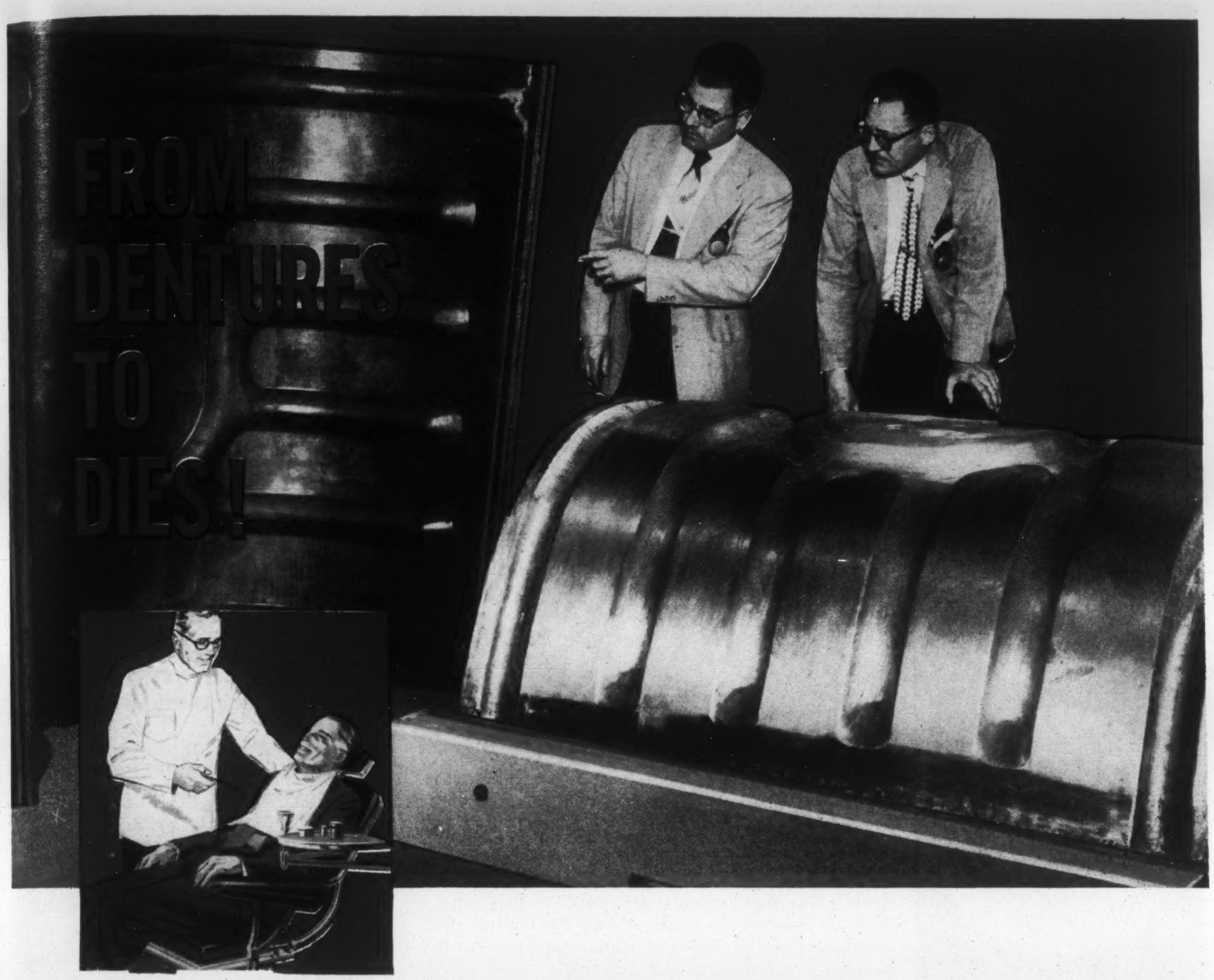
Registration fees are $8 for members, $14 for nonmembers. For additional information, contact John L. Everhart, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

Engineers

O. B. Schier, II has been appointed secretary of the American Society of Mechanical Engineers.

Rea Anderson is now chief metallurgist and head of the quality control dept., Standard Steel Corp. of Los Angeles.

D. J. DeMichele, General Electric Co., has been appointed general chairman of the 1958 annual national meeting



Molding compounds made with Thiokol liquid polymers give accurate reproduction, are inexpensive and easy to use

NEW plastic molding compounds made of epoxy resin and THIOKOL liquid polymers are being used throughout industry to improve quality and cut costs.

One of the most interesting applications is in the production of low cost plastic dies which not only provide remarkably faithful reproduction, but also make possible substantial savings in tooling costs. The parts pressed from such dies are accurate in every detail, and require no additional grinding, buffing or finishing. Easily cast and cured at room temperature with no harmful shrinkage, these resilient dies possess great impact resistance, and are virtually unaffected by solvents, oils, acids and alkalis.

Where intricate, extremely accurate, and flexible molds are required, THIOKOL liquid polymers are used as the base, with fillers added to provide the tensile and modulus strength desired. Compounds of this nature are used in the preparation of dental plates, reproductions of topographic maps, and other detailed reproductions. The dimensional stability and room temperature curing properties, and easy handling of these polymers make them ideal for a wide variety of applications.

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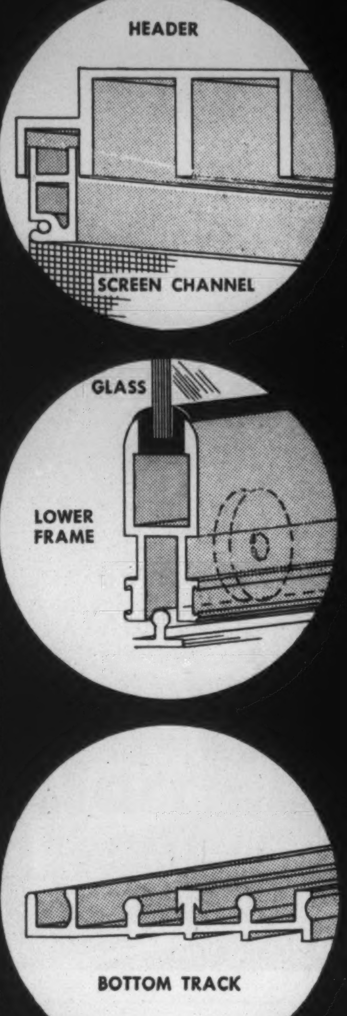
PE

EXTRUDED ALUMINUM IMPROVES GLASS WALLS 3-WAYS....



Sketches at left illustrate three of the six different "PE" extrusions used by Glass Shower Door Company, Chicago, in producing attractive "GSD" sliding walls.

Here's another example of how "PE Extrusioneering" has helped in simplifying fabricating and assembly, and at the same time contributed substantially to increase the product's acceptance. The case in point is involved with the manufacture of beautiful sliding glass walls produced by Glass Shower Door Company, Chicago. Three distinct benefits resulted from the combined efforts of "PE" and "GSD" engineers:

1 INCREASED SALES APPEAL
Slender aluminum members provided maximum areas for vision and light. Beautiful designs produced in attractive, corrosion-resistant finish, without costly machining.

2 GREATER STRENGTH WITH LESS WEIGHT
Extrusions permitted placement of extra metal exactly where needed to insure smooth finger-tip operation without danger of warping, swelling, or splitting.

3 LOWER FABRICATING AND HANDLING COSTS
Single piece extrusions replace several channels and angles, minimize fabricating operations, reduce inventory and handling costs. Surface finish requires no painting, eliminates peeling or chipping, cuts scrap losses.

● WRITE FOR FREE CASE STUDIES
For more facts about "PE's" extrusioneering service write for illustrated case study bulletins which cover solutions to various design problems, give helpful technical fabricating facts.

ADVANTAGES OF "PE" EXTRUSION MILL SERVICE

5,000 SHAPES
Available without die charge in a wide range of rod, bar, and tubing sizes, and numerous shapes.

NON-COMPETITIVE
We produce extrusions only, do not fabricate or manufacture any other product. You get experienced, confidential help in creating any special shape to suit your needs.

LOW DIE COST
Experienced engineering, design, and die making services save you time and money, make small or experimental runs practical.

VERSATILE EQUIPMENT
Small, medium, and large presses permit economical production. Complete integrated facilities from billet casting to finished extrusion.

PE
PRECISION EXTRUSIONS, INC.
727 E. GREEN AVENUE • BENSENVILLE, ILLINOIS
Phone: POrter 6-0098 • (Chicago) TUxedo 9-1701
Chicagoland's Oldest, Most Experienced Aluminum Extruder

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MILWAUKEE: Broadway 3-6446
GRAND RAPIDS: Glendale 1-2511

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of the Society for Experimental Stress Analysis.

Dr. W. F. Tuley is now group manager of chemical development, Naugatuck Chemical Div., U. S. Rubber Co.

Dr. Gerald M. Rassweiler has been appointed head of the physics & instrumentation dept. of General Motors Corp. Research Staff.

Carl S. Brown has been promoted to product development manager, Glascote Products, Inc., a subsidiary of A. O. Smith Corp.

Lewis W. Berger is now training supervisor, Metals Engineering Institute of the American Society for Metals.

Jean F. Gschwind has been appointed vice president of development and research, J. O. Ross Engineering Corp.

Alfred Augustine has been named director of engineering, **Edward A. Siemon,** chief engineer, and **C. R. Wilt, Jr.,** assistant chief engineer, Loftus Engineering Corp.

Richard H. Graham, head of Lockheed Missile Systems division's nuclear engineering and development section, has been named an advisor to the Atomic Energy Commission.

Lowell S. Pelfrey is now director of research & development, International Rectifier Corp.

Charles V. Campbell is now division engineer, Industrial Plastic Div., H. N. Hartwell & Son, Inc.

Stuart G. McGriff has been appointed product manager, fuels and propellants, Callery Chemical Co.

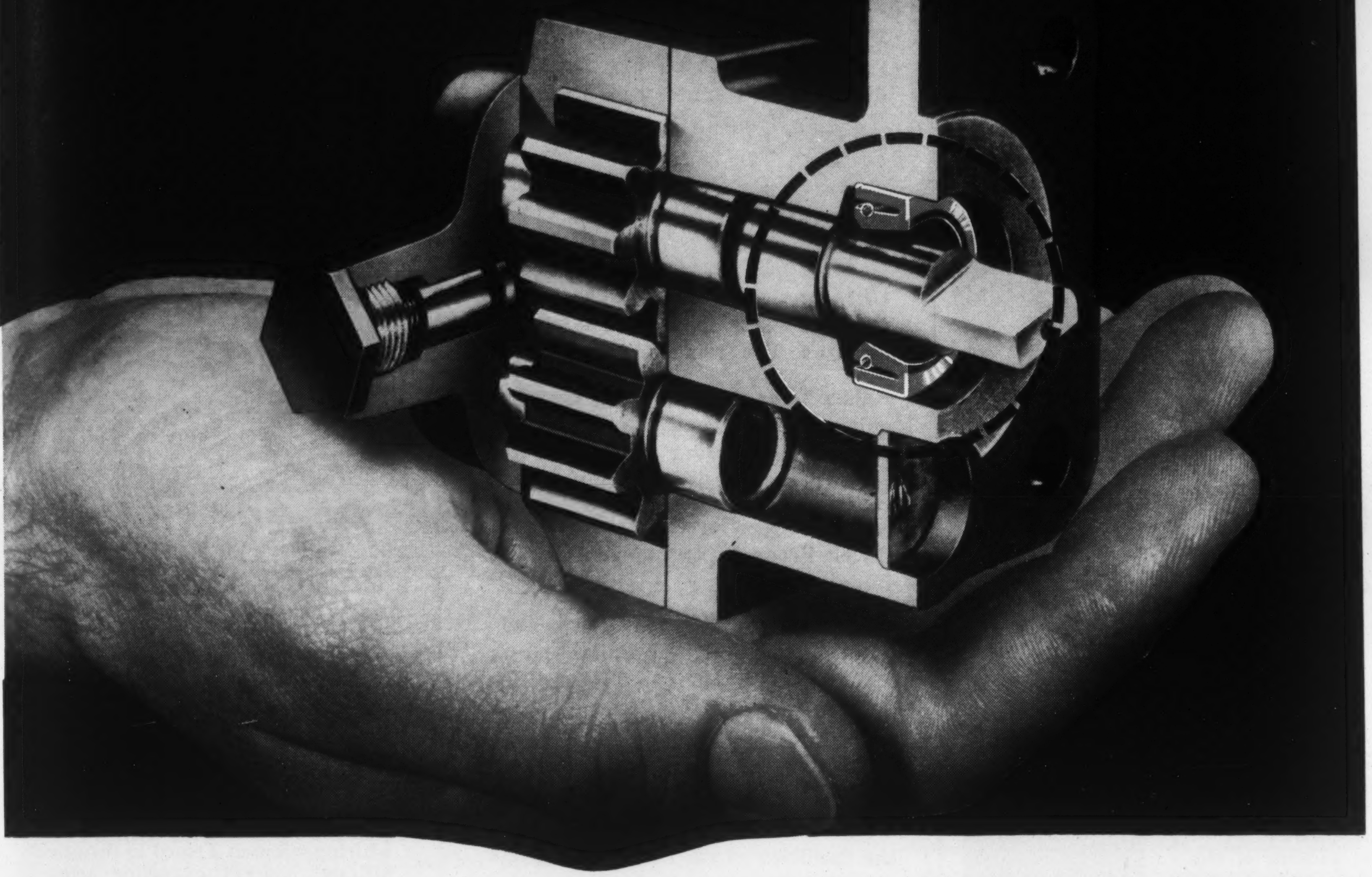
Robert S. Rosenast has been appointed production manager, Systems Div., Beckman Instruments Inc.

Dr. Donald E. Overbeek has joined Michigan Chemical Corp.'s research staff.

Dr. John N. Pattison has been appointed director of research and development, Chemical Products Div., National Cylinder Gas Co.

Arthur W. Kurz, Jr. has been named manufacturing manager, Congress

Champion performance in a fist-sized pump...sealed by C/R



THE PROBLEM:

To seal a rotary pump handling a wide range of fluid viscosities, pressures and temperatures

These pumps are performing dependably in hundreds of different hydraulic applications. They handle any fluid with lubricating qualities . . . deliver up to 180 gph, and maintain high volumetric efficiency even with low viscosity fluids. This particular pump also carries Underwriters' Laboratories approval for use in oil burners. For dependable sealing, C/R's Type HMS Oil Seal was chosen. It performs effectively from 28″ Hg to 5 psi, and from 50 to 8000 rpm. This is only one of the thousands of ways in which C/R Oil Seals and engineering are solving difficult sealing problems throughout industry. C/R engineers can help you, too—especially where critical conditions exist. A letter or telephone call will get them started for you. Write for your copy of the catalog, "C/R OIL SEALS."

More automobiles, farm and industrial machines rely on C/R Oil Seals than on any similar sealing device.

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OIL SEAL C/R DIVISION

CHICAGO RAWHIDE

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Die Casting and Congress Drives Divs., Tann Corp.

Dr. Edward Wichers has been appointed associate director for chemistry, National Bureau of Standards.

Companies

Ultradyne, Inc. has purchased the products and physical assets of **Quantum Electronics, Inc.**

Kaiser Steel Corp. has begun a two million dollar expansion program aimed at increasing the pipemaking capacity at its Napa, Calif. plant.

King-Seeley Corp. has purchased **Queen Products, Inc.** and **Albert Lea Building Corp.**

Westinghouse Electric Corp. will build a multi-million dollar power circuit breaker plant in Trafford, Pa.

National Steel Container Corp. is building a new 40,000-sq ft plant for the production of fibre drums.

Babcock & Wilcox Co. is increasing the facilities of its Tubular Products Div. for the production of alloy and stainless steel blooms and bars.

Anaconda Co. is negotiating to acquire all of the assets of **Cochran Foil Co.**

Permacel-Lepage's Inc. is the new name of **Permacel Tape Corp.**

Maysteel Products, Inc. has acquired **Magnesium Products Co.**

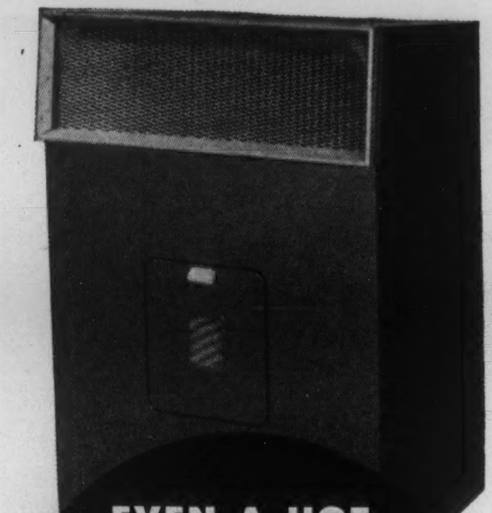
Goodyear Tire & Rubber Co. has completed a multi-million dollar expansion program aimed at raising the company's output of synthetic latex to 27,500 tons a year.

General Vacuum Corp. is the name of a new firm engaged in the manufacture of vacuum furnaces.

Everledge Mfg., Inc. is now operating at greatly increased capacity.

Morningstar, Nicol, Inc. announces that negotiations for its acquisition of **Federal Adhesives Corp.** have been virtually completed.

Bendix Aviation Corp. has purchased from **National Standard Co.** the



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the finish
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ONLY SICON "takes" the 550°F. temperature reached in sections of this Preway heater grille.

ONLY SICON protects this "Direction Flo-Grille" where temperatures often reach above 500°F.

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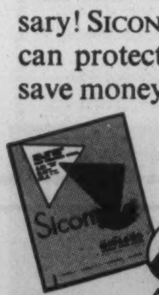
Brochure shows how SICON achieves more product appeal—withstands 550°F. temperatures without loss of color or gloss. Write for copy today.



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The upper grille of this handsome TEMCO Gas Wall Heater is finished with 7x7070 Brown SICON Silicone-Base Heat Resistant Finish. The number of louvers on this upper grille presented a chippage problem with vitreous enamel which prompted Temco to turn to SICON. Normal operating temperatures run about 350°F. but the temperature encountered on blocked flue conditions require a heat resistant finish to withstand 500°F...SICON 7x7070 Brown, on 25,000 or more Temco installations, has successfully met field performance requirements without loss of color, gloss or adhesion. Investigate other case histories of SICON—the remarkable finish that has solved over 150 heat resistant finish problems! Write today!

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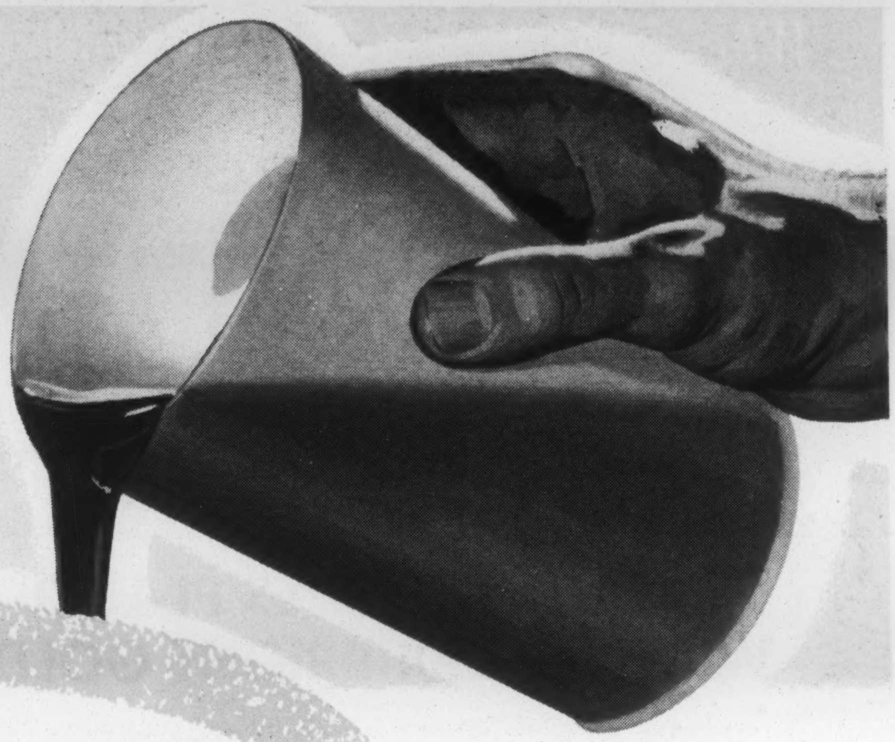
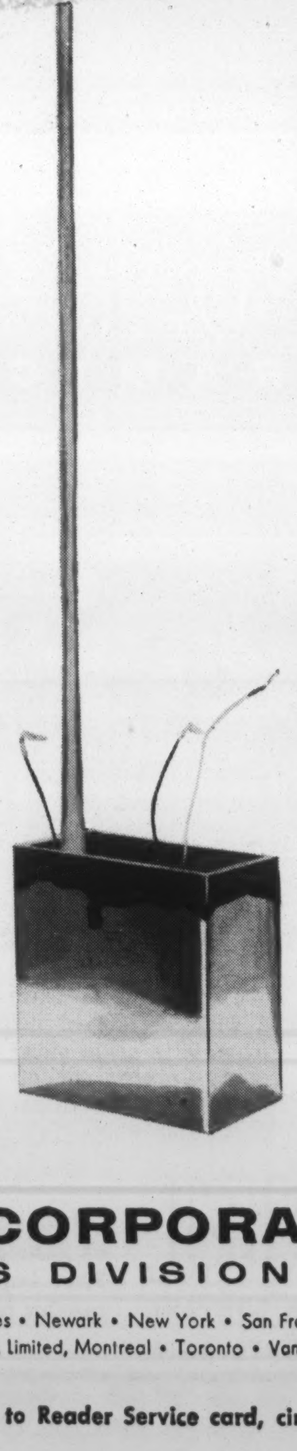


EPON® RESINS

. . . preferred for potting



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And, solvent-free Epon resin adhesive formulations . . . between glass, metal, or plastic . . . *cure at room temperature with contact pressure alone.*

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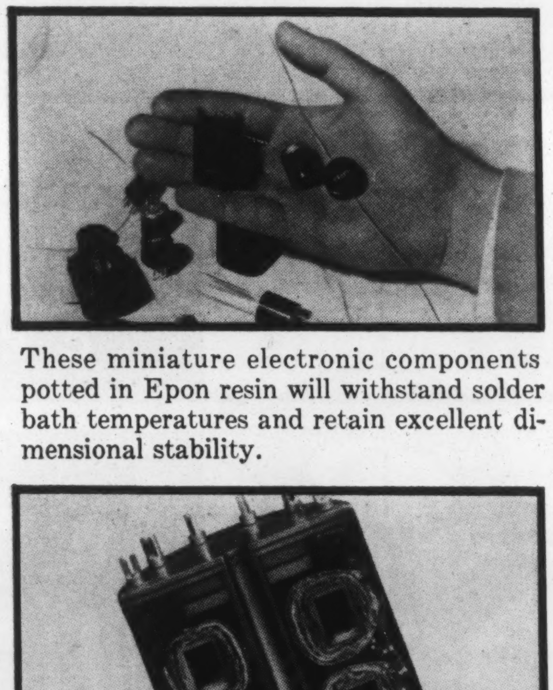
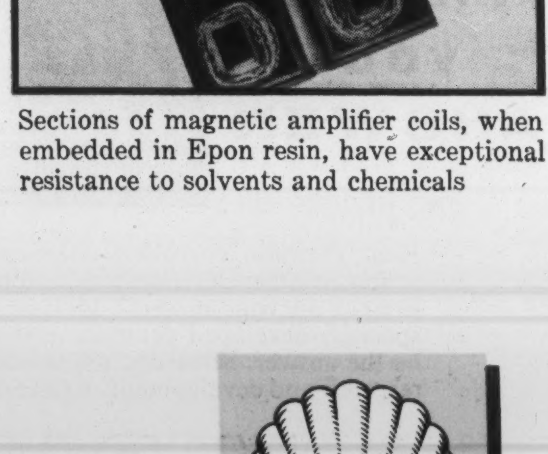


These miniature electronic components potted in Epon resin will withstand solder bath temperatures and retain excellent dimensional stability.



Sections of magnetic amplifier coils, when embedded in Epon resin, have exceptional resistance to solvents and chemicals

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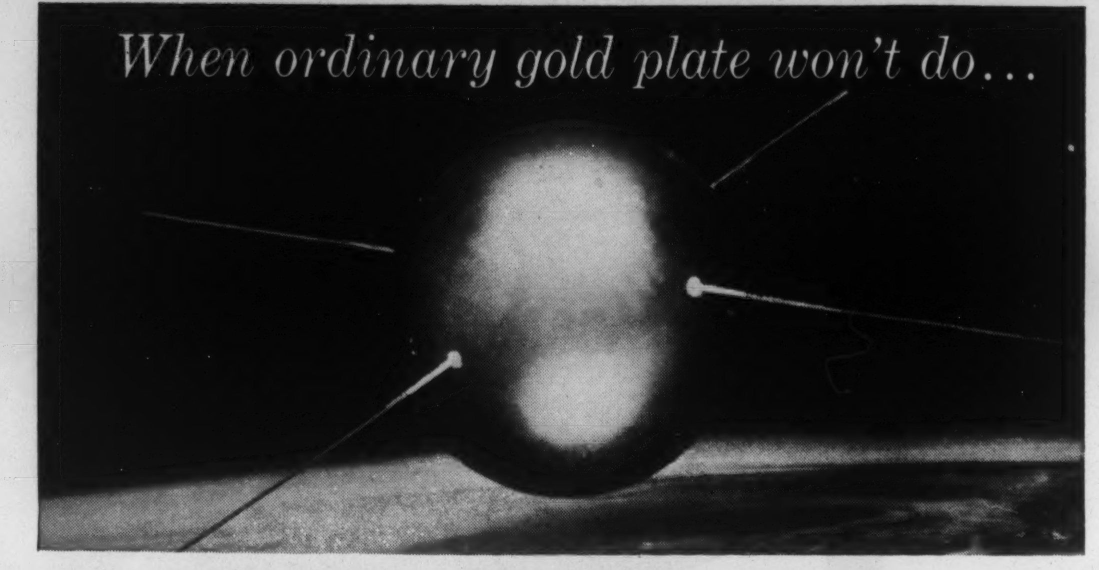

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. . . to provide maximum heat reflectivity and emissivity. This patented formulation was also used to plate most internal parts and instrument housings in the U.S. IGY Earth Satellites.

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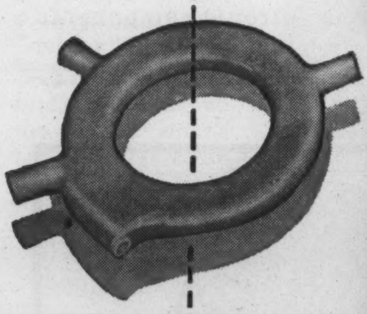

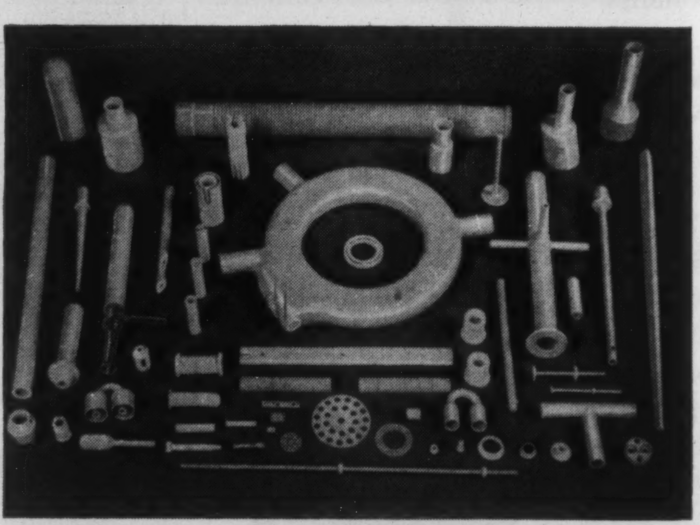

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News OF INDUSTRY

latter's interest in **Poroloy Equipment, Inc.**

Borden Co., Chemical Div., has expanded its polyvinyl chloride department by adding a new office and laboratory building.

Nylok-Detroit Corp. has moved to new quarters in the Jaikins Bldg., 1100 N. Woodward Ave., Birmingham, Mich.

National Petro-Chemicals Corp. will build its new 75,000,000-lb-per-year polyethylene plant in Houston, Tex.

Haveg Industries, Inc. has acquired **Reinhold Engineering and Plastics Co., Inc.** and will operate it as a wholly owned subsidiary.

Continental Diamond Fibre of Canada, Ltd. is the new name of **Diamond State Fibre Co. of Canada, Ltd.**

Square D Co. has completed an electrical equipment assembly plant in Atlanta, Ga.

Farnsworth Electronics Co., div. of International Telephone and Telegraph Corp., has broken ground for a $3 million manufacturing plant.

Graton & Knight Co., Inc., manufacturers of industrial leather products, has purchased **Warren Belting Co.** Warren will operate as a division of Graton.

Ogden Corp. has acquired **Eimco Corp.** and **American Foundry & Machine Co.**

Societies

Society of Automotive Engineers, Inc. has elected the following 1958 officers: president—William K. Creson, Ross Gear and Tool Co., Inc.; and treasurer—B. B. Bachman, Autocar Div., White Motor Co. Vice presidents and the professional activities they represent are: air transport—C. M. Christenson, United Air Lines, Inc.; aircraft—H. W. Holzapfel, AiResearch Aviation Service Co., Div. of Garrett Corp.; aircraft powerplant — C. E. Mines, Allison Div., General Motors Corp.; body—E. J. Premo, Chevrolet Motor Div.,

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Spring wire puts new life in old tires

Old tires begin a whole new life as raw material for durable, resilient doormats. And Bethlehem galvanized spring wire plays an important role.

First, the casing is slit into strips ⅜ in. wide and these in turn are chopped into blocks 2½ in. long. A ¾-in. hole is punched through each end of the rubber blocks, which are then strung over lengths of Bethlehem hot-dip galvanized spring wire bent into a block U-shape.

When the mat has been woven to desired size, it is compressed and the free ends of the wire are trimmed, closed, and finished off with a small ferrule. A mat like this will withstand years and years of constant scuffing, jerking, twisting—thanks in good measure to the sinewy toughness of Bethlehem spring wire and its moisture- and abrasion-resisting coating of zinc.

Spring wire is only one of the many specialties that Bethlehem produces regularly in its modern wire mills. Each kind of Bethlehem wire has the right strength, ductility, finish, and other properties required to give best results for a specific application. A Bethlehem representative would be glad to talk over your wire needs with you. Just get in touch with the nearest Bethlehem sales office.

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CORDON CIRCUIT BREAKER

The I-T-E "Cordon"® Circuit Breaker is designed to safeguard low-voltage distribution circuits against fault currents up to 100,000 rms. amperes. Through the coordination of thermal-magnetic, and current-limiting action, protection is provided against momentary overloads as well as low or high magnitude fault currents. In one compact, easily installed, easily serviced unit, "Cordon" supplies an economical solution to ever-increasing interrupting requirements.

I-T-E's high quality-standards for its "Cordon" Circuit Breaker are met by Chace Thermostatic Bimetal, a product of over a third of a century of specialization. Precision-formed by Chace to the closest tolerances, Chace Bimetal qualifies for the job only after a relentless series of tests and inspection procedures. Chace Thermostatic Bimetal is formed by a special process to prevent metal-separation and to assure that each unit will perform its equipment-safeguarding role with instantaneous, automatic, and unfailing action at all times. It is for reasons such as these that Chace Thermostatic Bimetal is specified for actuating the widely-used, high-quality I-T-E-"Cordon" Circuit Breaker.

Remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in over 30 types, in strip, coil or completely fabricated and assembled elements made to your specification. (We do not manufacture complete controls or any other devices in competition with our customers). Write today for *new* 1958 booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data that may help you solve your design problems.

IT BENDS WITH THE HEAT

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Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

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News OF INDUSTRY

General Motors Corp.; diesel engine—L. D. Thompson, Utica-Bend Corp., a subsidiary of Curtiss-Wright Corp.; engineering materials—E. S. Rowland, Timken Roller Bearing Co.; fuels and lubricants—R. Wayne Goodale, Lubricant Div., Standard Oil Co. of Calif.; passenger car—P. H. Pretz, Ford Motor Co.; production—J. E. Adams, White Motor Co.; tractor and farm machinery—Merlin Hansen, John Deere Research and Engineering Center; transportation and maintenance—E. B. Ogden, Consolidated Freightways, Inc.; and truck and bus—R. R. Burkhalter, Dana Corp.

Structural Clay Products Research Foundation has re-elected the following officers: chairman—Roy A. Shipley, Natco Corp.; vice chairman—William A. Crossan, Metropolitan Brick, Inc.; secretary—Harry C. Plummer, Structural Clay Products Institute; treasurer—A. C. Frisk, Mason City Brick & Tile Co.; and director—Robert B. Taylor.

American Society of Mechanical Engineers has bestowed the honor of Fellow of the Society to its following members: Richard G. Folsom, University of Michigan; Albert N. Horne, Texaco-Cities Service Pipe Line Co.; Jerome J. Kanter, Crane Co.; Myron A. Kendall, Stephens-Adamson Mfg. Co.; Harold E. Martin, Metal and Thermit Corp.; Harold B. Maynard, Methods Engineering Council; Gordon R. Milne, Consolidated Edison Co.; Arthur H. Morey, General Electric Co.; Arthur M. Perrin, National Conveyors Co.; George A. Porter, Detroit Edison Co.; J. Kenneth Salisbury, consulting engineer; Harold S. Sizer, Brown and Sharpe Mfg. Co.; and Ronald B. Smith, M. W. Kellogg Co.

American Institute of Mining, Metallurgical and Petroleum Engineers has elected the following to honorary membership: Dr. Champion Herbert Mathewson, Yale University; Donald Hamilton McLaughlin, Homestake Mining Co.; and Fred Searls, Jr., Newmont Mining Corp.

(News of Meetings on p 260)

A high speed punishment test on the Kansas Turnpike would induce a side wobble in power mower wheels with metal ball bearings. But in this "Mastercut" mower wheel, the nylon bearings didn't even show signs of wear. H. R. Lasater (left), Ray Hodge, and Al Kearney examine wheel after test.

This Power Mower Went 70 Miles Per Hour!

Torturous test proves advantages of Spencer Nylon bearings over metal. And these bearings cut materials costs 70%:

"Use plastic for bearings in our mowers?" H. R. Lasater, service manager of Aircapitol Manufacturers in Wichita, Kansas, was dubious. "Why, it would never stand up in power mower wheels!"

"Spencer Nylon will stand up— better than the average ball bearings!" The reply came from young Ray Hodge, President of Midwest Plastics Corporation, 451 North Water in Wichita. "Test it and see!"

Accepting Hodge's challenge, Lasater consulted his chief inspector, Al Kearney. The test they dreamed up was probably the most rugged—and the most spectacular—ever devised for power mower wheel bearings. They hooked up one of their "Mastercut" power mowers—equipped with bearings made from Spencer Nylon—to the back of a car.

Then they towed the mower 102 miles on the Kansas Turnpike, six miles of the journey at 70 miles per hour—a pace that would induce a side wobble with metal ball bearings. After the test, however, the nylon bearings showed no sign of wear. Today the majority of "Mastercut" mowers have bearings of Spencer Nylon made by Midwest Plastic.

These nylon bearings cut materials costs 70% over the metal bearings previously used. They're easy to install, and they need less lubrication than metal. Oiling lasts a whole season with nylon bearings, Lasater reports.

More and more manufacturers are replacing metal with nylon every day. Wherever you need a part that is plastic-light yet metal-strong, it is a good idea to consider nylon.

You too may find that Spencer Nylon can help cut your materials costs and help solve your design problems. For the names of molders who can supply you with nylon gears, bearings, and machine parts, write to Spencer Nylon, Spencer Chemical Company, 700 Dwight Building, Kansas City 5, Mo.

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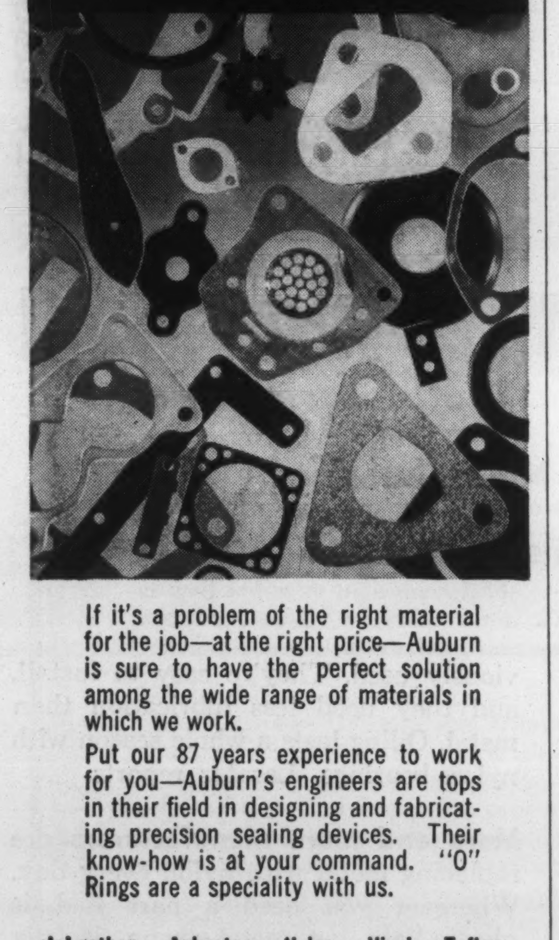

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For more information, circle No. 379

News OF INDUSTRY

Meetings

Design Engineering Conference, American Society of Mechanical Engineers, Machine Design Div. Chicago. Apr 14-17.

Design Engineering Show. International Amphitheatre. Chicago. Apr 14-17.

American Welding Society, annual meeting and welding show. St. Louis. Apr 14-18.

Metal Powder Assn., annual meeting and powder metallurgy show. Philadelphia. Apr 21-23.

Electrochemical Society, spring meeting. New York City. Apr 27-May 1.

American Society of Tool Engineers, 26th annual meeting and tool show. Philadelphia. May 1-8.

Porcelain Enamel Institute, midyear divisional conference. Chicago. May 13-14.

Society for Experimental Stress Analysis, spring meeting. Cleveland. May 14-16.

American Electroplaters' Society, annual convention. Cincinnati. May 19-22.

American Foundrymen's Society, 62nd castings congress and foundry show. Cleveland. May 19-23.

National Telemetering Conference and Exhibit, American Institute of Electrical Engineers, American Rocket Society, Instrument Society of America and Institute of Aeronautical Sciences. Baltimore. June 2-4.

American Rocket Society, Inc., semi-annual meeting. Los Angeles. June 8-11.

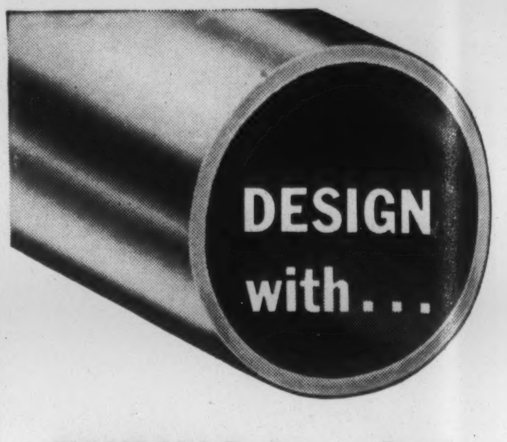
Malleable Founders' Society, annual meeting. Hot Springs, Va. June 9-10.

American Society of Mechanical Engineers, semi-annual meeting. Detroit. June 15-19.

American Society for Testing Materials, 61st annual meeting and apparatus exhibit. Boston. June 22-28.

American Institute of Electrical Engineers, summer general meeting. Buffalo, N. Y. June 23-27.

Society of the Plastics Industry, Inc., Midwest section conference. French Lick, Ind. June 26-27.



TUBING in mind

The increasing use of tubular sections in parts production—many of them relatively complex, and often not resembling tubing at all in their final form—commands the attention of design and production engineers.

BETTER PARTS AT LOWER COST

There are outstanding reasons for this trend toward tubing as a raw material for small parts: You start with a material of close tolerances; it is available in practically any ductile metal; has better grain structure, further improved by cold working; offers extremely low scrap loss; requires less machining and usually no surface finishing; it is an aid to precision miniaturization; provides required strength with minimum weight—to mention only a few.

INDUSTRY-WIDE PERSPECTIVE

Profit from Uniform's "Tubing Know-how", gained through more than 20 years of specialization in the manufacture and application of small tubing. Discuss your parts problems with us and let us show you where tubular sections have improved similar products, speeded up production and reduced costs for other manufacturers.

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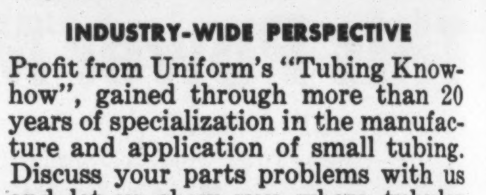
Uniform Tubing is available in sizes from .625" O.D. down to .010". Wall thickness down to .001". Tolerances to .00025" if required. Every order is "made to order"—to exact specifications. Delivery is 3 to 4 weeks or better —a matter of days in the emergency.

Tubular Components. Have your tubing parts "made at the mill"—by skilled tubing fabricators, in our extensive forming and machining plant.

Cut sub-contracting cost, concentrate responsibility, get better delivery of finished components, ready for assembly.

Send drawings for quotations or write for literature.



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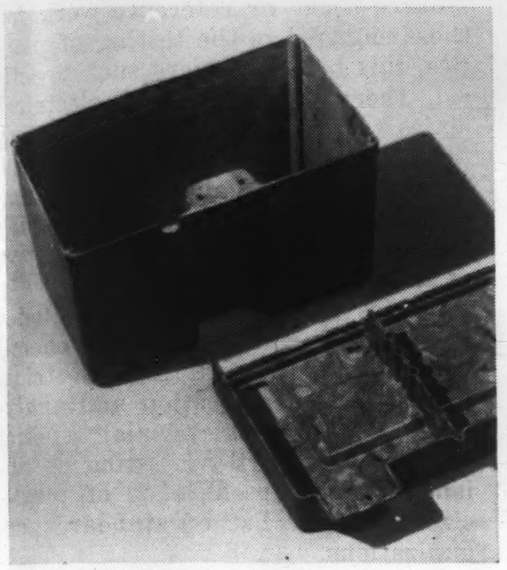
PRODUCT-DESIGN

MEMOS FROM DUREZ

High-impact phenolic | **Automatic molding** **Phenolic for appliances**



Flying saucer?

This plastic housing helps airmen find out what's cooking on the roof of the world.

It's part of a radiosonde, a device that has sparked many flying-saucer reports.

Dropped from a high-flying weather reconnaissance plane over an ocean or arctic ice, the radiosonde flips its plastic lid, releasing a parachute.

The ballooning chute yanks an antenna line out of the case. Then, as the device drifts groundward, it broadcasts a code report on air temperature, pressure, and humidity every six seconds.

Picked up by radio men, these signals enable the Air Force to piece together accurate forecasts of flying weather over remote frontiers.

The snap-off housing is molded of *Durez 16771 Natural,* selected for its impact strength and its ability to stand extremes of temperature and humidity.

In sharp contrast to the mass production of phenolic parts, this use of Durez suggests its ability to meet *your* out-of-the-ordinary requirements.

If you'd like technical data on 16771 Natural, check the coupon. For information on other special-purpose phenolics, write us, outlining the problem.

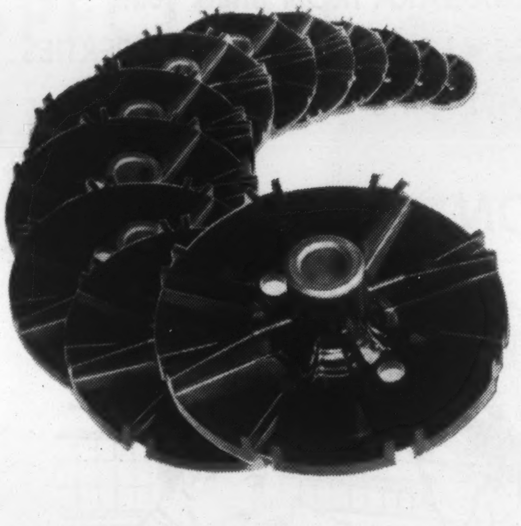
Big job, big saving

What's hot in phenolics? *Automation.*

Automatic molding of a 4¾-inch diameter water-pump impeller for new Ford cars, trucks, and tractors has made possible a switch from cast iron to phenolic—with substantial reductions in weight, production time, and cost.

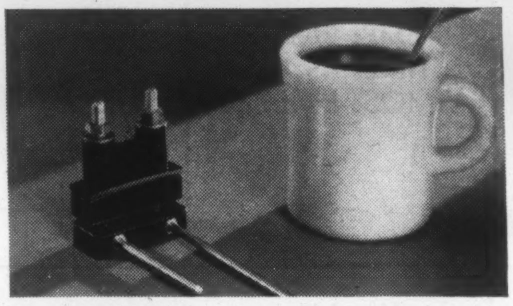
The impellers are molded 12 at a shot on the largest capacity compression molding press ever to operate on fully automatic cycle.

The material selected for the impeller is a Durez phenolic impervious to antifreeze and antirust solutions, combining moisture resistance with dimensional stability in high degree.



Thinking big? You'll find there are many ways in which mass-production molding and Durez phenolics can team up profitably for you. The versatility and exceptional batch-to-batch uniformity of these compounds assure best possible results on highly automated production lines.

Ask your molder or your Durez sales representative to suggest how you can put these advantages to work in your products.



Durez and the coffee-break

Appliance makers can tell you that wherever coffee perks, bubbles, or pours into a cup, there's likely to be a Durez phenolic close by.

Electrical components, handles, knobs—these are just a few essentials of a coffee-break, in which Durez molding compounds play an unassuming part.

A prime requisite for this sort of assignment is the ability of phenolic to resist coffee stains and chemical deterioration. The appliance designer also looks for:

- excellent surface finish
- good dimensional stability
- coolness to the touch
- crack resistance when molded around large inserts

If *you're* looking for properties like these, you can find them all in *Durez 791 Black*. They're exemplified in the component shown here, an electrode assembly for a king-sized coffee maker and dispenser.

For more facts on versatile 791 Black, check the coupon.

For more information on the Durez materials mentioned above, check here:

☐ High-impact Durez 16771 Natural—data sheet
☐ Phenolic molding compounds—descriptive bulletin
☐ General-purpose Durez 791 Black—data sheet

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ® HOOKER CHEMICALS PLASTICS

PLASTICS DIVISION
HOOKER ELECTROCHEMICAL COMPANY
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NIAGARA 100 MESH
HYDROGEN REDUCED IRON POWDER

Is The Answer To Your Dimensional Growth Problems

This table shows the high tensile strength obtainable for iron-copper-structural parts:

Sintering Conditions	Copper Content %	Sintered Density GRM/cc	Dimensional Change From Tool Size %/ inch	Tensile Strength p.s.i.
TEMP: 2050°F TIME: 45 Mins. ATMOS: Hydrogen	0	5.8	—0.25	18000
	3	5.8	—0.10	27000
	5	5.8	+0.20	36000
	7	5.8	+0.30	40000
	10	5.8	—0.01	42000

In addition to these properties NIAGARA IRON offers you:
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The Jarl salesman is an engineer—able to understand your design problems . . . ready to answer your questions knowingly . . . qualified to make on-the-spot decisions. Before your extruded part or product is put in production, every man on the design team is thoroughly indoctrinated with all pertinent facts covering your requirements.

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TECHNICAL LITERATURE

(cont'd from p 45)

Books

The Properties and Testing of Plastics Materials. *A. E. Lever and J. Rhys. Chemical Publishing Co., Inc., New York, 1958. Cloth, 6 by 9 in., 200 pp. Price $4.75*

Described by the authors as a "source book" or reference work for those engaged in the testing of plastics, this book considers such practical, thermal, optical and electrical erties of plastics as fabricating techniques and service conditions. According to the authors, the value of testing lies in the degree to which the test specimen is representative of the final product.

Topics covered in the book include: general principles; physical, chemical, thermal, optical and electrical properties; identification and analysis; industrial materials; special tests and properties; testing of finished moldings; efficiency of plasticizers; and a list of standards organizations.

The book contains comparative technical information, much of it in tabulated form, on a wide variety of plastics materials including cellulose acetate, ethyl cellulose, polyethylene, polyvinyl acetate, polystyrene, silicone, nylon, polyester, polyvinyl chloride and copolymers, acrylic, phenolic, melamine, urea and allyl resins. Included are 1600 references, a comprehensive glossary, and an extensive index.

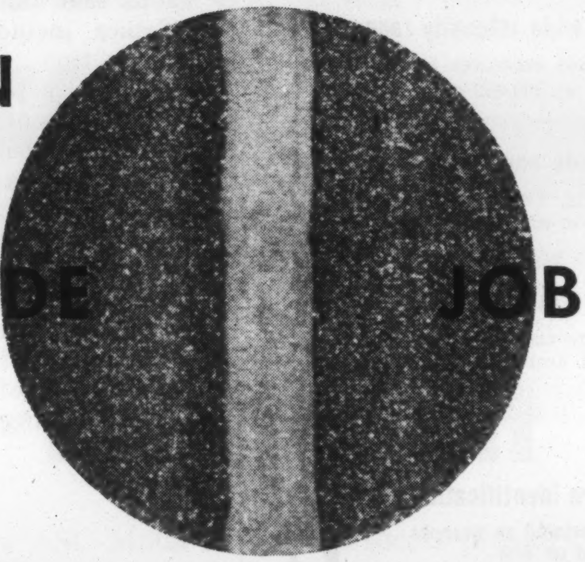
Engineering Materials Handbook. *Edited by Charles L. Mantell. McGraw-Hill Book Co., New York, 1958. Cloth, 6 by 9 in., 1936 pp. Price $21.50*

This book, the work of 150 contributors, provides detailed information on the properties, uses, advantages and limitations of fabricated forms of engineering materials, including ferrous and nonferrous metals, plastics, glass, ceramics, rubber, paints, fibers, wood, paper and cermets. The materials are considered from the viewpoint of engineering structures, machinery and equipment.

Well illustrated with tables and graphs, the book, in addition to giving properties of materials, gives information on problems of corrosion; protection against such corrosion and deterioration as a function of design and materials selection; season cracking; brittle and mechanical failure; scaling and loss of properties; notch brittleness; fa-

Paul Henry uses a boroscope to inspect the magnified image of the weld seam.

INSPECTION WITH US IS AN INSIDE JOB



Damascus checks the inside as well as the outside of every piece of stainless steel pipe and tubing. With the help of a boroscope, the weld seam is examined along its full length. Skilled inspectors sort out faulty tubes . . . eliminate possible failures. The Damascus stamp of approval is your assurance of a sound product, carefully selected to fill your order.

For prompt mill shipments of stainless steel pipe and tubing in a wide range of sizes and A.I.S.I. analyses, call Damascus direct — for local service call your nearest STEEL SERVICE CENTER.

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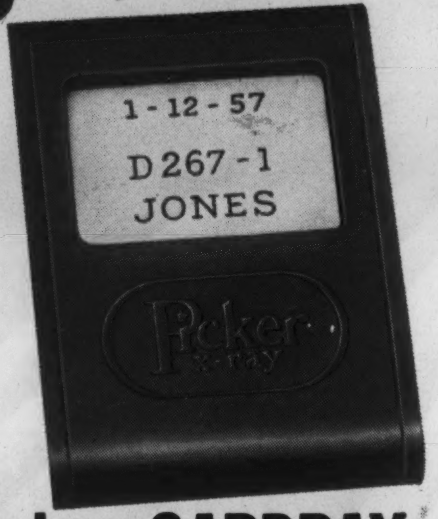
9 ways better



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Separate control badge guards against accidental fogging.

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Wear badge as received, return it intact.

6 **prompt reporting**
Dependable, easy-to-read, too.

7 **compact, lightweight**
See size above: less than 1 oz.

8 **attractive, unobtrusive**
Clips on firmly, won't catch clothing.

9 **durable**
Secure snap-locks, won't come undone, won't break.

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tigue; stress rupture; and high temperature service.

The editor, Dr. Mantell, is chairman of the Dept. of Chemical Engineering, Newark College of Engineering.

Proceedings Thirteenth Annual Meeting Metal Powder Association: Volume I. *Metal Powder Assn., New York, 1957. Paper, 6 by 9 in., 147 pp. Price $4*

Written by American, European and Canadian authorities in the field of powder metallurgy, the papers given in this volume cite the properties, uses and fabrication of ferrous and nonferrous metal powders. Topics include activated sintering; production and characteristics of chemically precipitated copper powder; current developments in the rolling of both ferrous and nonferrous powders; fiber metallurgy; primary considerations in the design and use of sintered metal parts; production and characteristics of chemically precipitated nickel powder; new developments in metal powder filters; superfine iron powders; fundamentals of powder metallurgy; and sintering of iron-copper-carbon compacts.

Reports

Silicone resins DEVELOPMENT OF THERMALLY STABLE SILICON CONTAINING RESINS. *L. W. Breed, Fred Baiocchi and H. W. Christie, Midwest Research Institute. May '57. 52 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. Price $1.50 (PB 131190)*

Information on the synthesis of silane monomers to form a thermosetting polymer when hydrolyzed and cured. Describes a series of tests for studying the formation of silicone-glass laminates.

Machining titanium MANUAL ON THE MACHINING AND GRINDING OF TITANIUM AND TITANIUM ALLOYS. *Carl T. Olofson, Battelle Memorial Institute. Aug '57. 94 pp. Available from Titanium Metallurgical Laboratory, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio. (Rpt No. 80)*

The manual consists of an introductory section, seven sections on various machining processes, and two

how to
CUT
COSTS
on small
components

If the cost of metal stampings and wire forms figures in your profit picture, let us give you a quotation on your current components. Send us a sample or blueprint . . . and discover how big savings in time and production costs, big gains in precision and uniformity are possible on small components, when Art Wire tackles the job!

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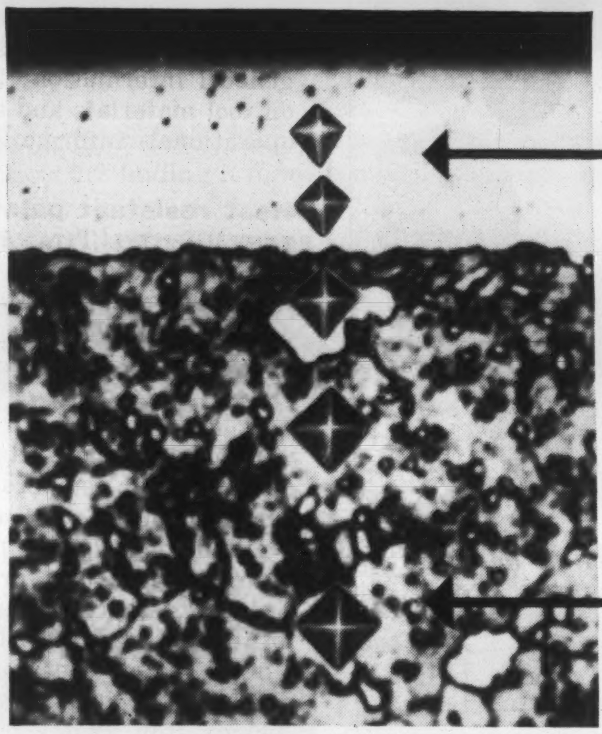

Conditions: Nital Etch, (1500 X), 10 gram load

Photomicrograph of Vickers test on AISI 440-C Air Hardening Tool Steel after ASC Diffusion treatment, indicating core and surface hardness.

70-76 Rc SURFACE HARDNESS

60-63 Rc CORE HARDNESS

without Heat Treatment

The new, revolutionary ASC Metal Diffusion Process provides the surface hardness and core hardness you require on Air Hardening Steels *without the necessity of further heat treatment.*

. . . for sliding, rolling, driving or driven applications where frictional *wear* is created by mating parts action.

. . . for high temperature applications where *wear* resistance is vital.

. . . for corrosion applications where high or low temperature causes excessive *wear*.

The unique ASC Metal Diffusion Process produces a carbide wear surface that becomes an integral part of the parent metal. It is not a plating. It is not a coating. It is not a cladding. ASC processed metals will not craze, crack, or peel. Dimensions will not increase more than 0.001″ in any direction through processing.

We'll be glad to process samples and recommend the best steel for your particular application.

Write or call, there's no obligation.

TYPICAL APPLICATIONS
- Forming, crimping and seaming rolls
- Mandrels for cold drawing tubing
- High temperature bearings
- Metal drawing and extruding dies
- Plastic extrusion dies
- Cams and cam followers
- Pump plungers, discharge valves and seats

RECOMMENDED STEELS
- AISI type D1, 2, 3 tool steels
- 440 A, B, C, Stainless
- Hi-speed steels not containing tungsten
- Trade Name Steels such as:
  - BR-4
  - CCN
  - Ontario
  - Airdi 150
  - Vasco Jet 1000
  - Cromovan
  - Carpenter 610

ALLOY SURFACES COMPANY

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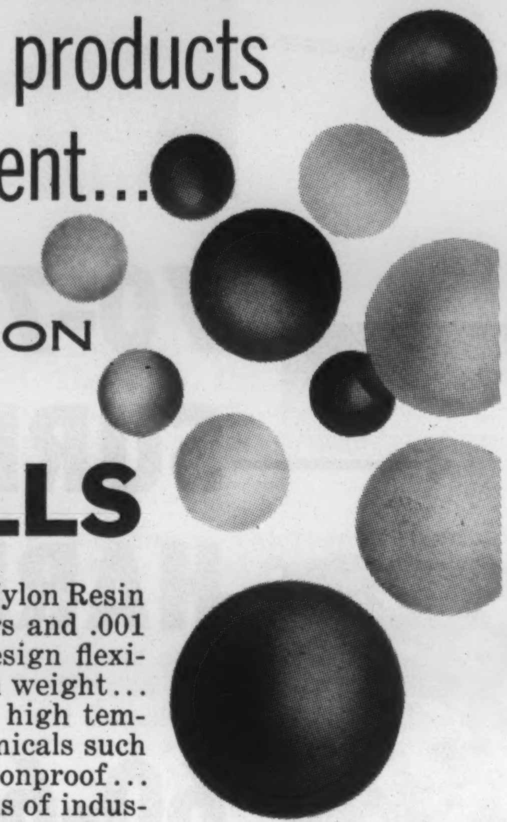
new way to make products better, more efficient...

ACE PRECISION NYLON BALLS



Precision manufactured from DuPont Nylon Resin to close tolerance of ±.001 on diameters and .001 on sphericity, Ace Nylon Balls give design flexibility and production economy. Light in weight... tough at low temperatures... stable at high temperatures... resistant to corroding chemicals such as sulphuric acid, etc.... almost abrasionproof... these mass-produced balls have hundreds of industrial applications. Come in 14 standard sizes from ⅛" to ¾".

Complete facilities for fabrication of plastic parts for all industries. Estimates submitted promptly on receipt of blueprints or specifications.

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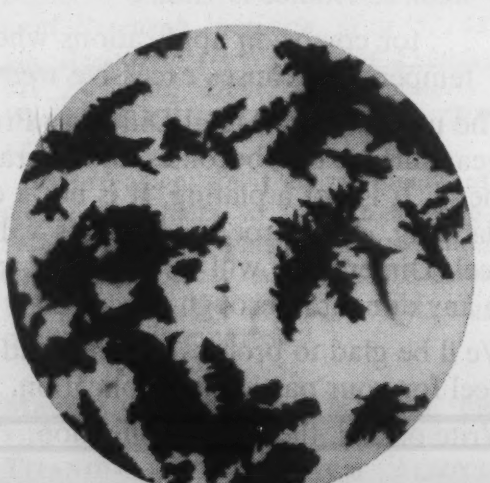
"Fernlock" is a dendritic copper powder offering a hard to get combination of properties not found in either flake or granular copper powders. Check these special features. Fernlock may be just the material you need for that special problem.

1. High Purity (99.50% Min.)
2. Low Density (1.1 gr/cc Max.)
3. Fine Mesh Size (75% through 325)
4. Dendritic Particle Structure (See Photo—250 diameters)
5. Very High Green Strength (The particles interlock under pressure)



MALONE METAL POWDERS, INC.

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Flemington, New Jersey
Phone: WIsconsin 7-7250

For more information, turn to Reader Service card, circle No. 422

appendixes. Each machining section is composed of three subsections: 1) general information; 2) information on tool materials and shapes; and 3) operational information and data.

Heat resistant paint HEAT RESISTANT DIBUTYL TITANATE PAINTS FOR ROCKET LAUNCHERS. *T. Rice, Rock Island Arsenal Laboratory. May '56. 20 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. Price 50¢ (PB 131268)*

Dibutyl titanate-base paints have excellent high temperature resistance but appear to offer no advantages over silicone-type paints for use on high temperature ordnance materials. Resistance to temperatures up to 1000 F was recorded in tests of dibutyl paint containing aluminum flake, zinc dust and olive drab (chiefly iron oxide) pigments.

Metal grating METAL GRATING HANDBOOK. *1957. 32 pp. Available from Metal Grating Institute, Inc., One Gateway Center, Pittsburgh 22. Price $1*

This bulletin, said to be the "first all-inclusive technical publication to represent a product standardization in the metal grating industry," establishes standards and specifications for the design and use of metal grating in a number of industries, it also contains a glossary of terms and definitions used throughout the metal grating industry.

Abrasion resistant plastics PLASTIC MATERIALS FOR VISION DEVICES. *Edwin A. Swire, Armour Research Foundation. May '54. 38 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. Price $1 (PB 121027)*

Abrasion data obtained with falling carborundum and measured by variations in surface gloss have shown that such commercial plastics and elastomers as methyl alphachloroacrylate, allyl diglycol carbonate, methyl acrylate and crosslinked polyesters have abrasion resistance superior to that of methyl methacrylate and approaching that of glass.

Filler metals FILLER METAL COMPARISON CHARTS. *1957. 24 pp. Available from American Welding Society, 33 W. 39th St., New York 18. Price $2 (AWS A5.0-57)*

Comparison charts showing AWS and ASTM classifications and brand names for mild steel, iron, alumi-

Excellent Machinability of Magnesium Cuts Production Costs

Easy machining means faster machining, less wear on tools, lower costs

Designers working in today's highly competitive markets are finding it more important than ever to consider production costs when they're selecting materials. Magnesium alloys offer much needed economies in this respect. In fact, few other structural metals are so versatile and easy to work with in production operations.

Take machining, for example.

The excellent characteristics of magnesium alloys permit machining operations at extremely high speeds—usually at the maximum obtainable speeds of modern machine tools. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium. The life of high speed steel cutting tools when machining wrought magnesium is equal to the life of carbide tipped tools when machining other metals!

MAXIMUM OPERATING SPEEDS of automatic machine tools can be utilized in machining magnesium.

Magnesium lightness, which allows easy, efficient handling of large parts, plus excellent machining characteristics add up to substantial savings in production costs.

TURNING AND BORING. A wide range of cutting speeds, feeds and depths of cut are possible in turning and boring magnesium. Rough cuts vary from 300 fpm, 0.100 ipr and 0.800" in depth to 5,000 fpm, 0.010 ipr and 0.150" deep. Finish cuts may vary from 300 fpm, 0.025 ipr and 0.100 inches to 5,000 fpm, 0.003 ipr and 0.050 inches.

MILLING. The outstanding machining characteristics of magnesium can be used to full advantage in milling operations. Heavy feeds and milling speeds up to 9,000 fpm remove the metal rapidly with excellent surface finish.

DRILLING. The maximum speeds of standard drilling equipment can be utilized to the fullest extent. Speeds used in commercial shops on other metals are 75 to 400 fpm, but speeds up to 2,000 fpm can be used with magnesium.

SAWING. Magnesium is readily cut with band, circular, hand or power hack saws. Because of the low cutting pressure, larger cuts can be taken per tooth than are possible with other metals.

AUTOMATIC SCREW MACHINE WORK. Extruded magnesium screw machine stock is available in all common sizes and shapes. It usually costs less on a cost-per-part basis than any other metal except steel. The use of magnesium permits feeds as much as 50% to 75% higher than those used with brass. Magnesium causes less tool wear, which lowers tool cost and reduces machine down time.

It is often possible to reduce part costs because of the low power consumption, the high feeds and speeds and the excellent surface finishes that result from using magnesium. The light weight of the metal exerts less wear on spindles, belts and motors, especially where quick changes of speed are involved.

TAPPING AND THREADING. Threads which are not held to close tolerances may be tapped in magnesium alloys with standard taps. Threads may be chased in magnesium alloys at the rate of 1,000 feet per minute.

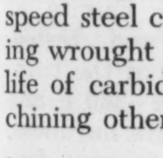
GRINDING AND POLISHING. Finish grinding of magnesium is often unnecessary inasmuch as finishing cuts give extremely accurate and smooth surfaces. Rough grinding, however, is widely used in foundry clean-up and for removing flash from die castings and forgings.

Polished surfaces of any desired quality are easy to obtain on magnesium. Surface irregularities are removed readily by polishing operations. High lustre surfaces on articles to be plated or used for decorative purposes can be produced by buffing.

In all other machining operations, such as shaping and planing, reaming, counterboring and filing, the advantages of magnesium also pay off in terms of faster production, lower costs and less tool wear. Thousands of metalworking shops are efficiently and safely working with magnesium every day. Why not consider magnesium for the products or parts you're working with now?

METAL	RELATIVE POWER REQUIREMENT
magnesium	1.0
cast aluminum	1.8
brass	2.3
cast iron	3.5
rolled aluminum	5.0
mild steel	6.3

RELATIVE POWER required to machine different metals under the same conditions is shown by this comparison (1.0 = lowest power required).



MACHINING MAGNESIUM, a 60-page handbook, discusses all methods of machining mentioned above. Also includes tables on speed, feed and depths of cut, basic information on magnesium properties, tool design and safe procedures. For your copy, contact the nearest Dow office or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1453J.

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num, copper alloy, tungsten, nickel alloy and stainless steel welding rods and electrodes. The brand names of 61 companies and 12 AWS-ASTM specifications are included. Two indexes list brands as well as manufacturers' names.

Vacuum treating PRACTICAL VACUUM TREATING OF NONFERROUS MELTS AT THE U. S. NAVAL GUN FACTORY. *V. De Pierre, U. S. Naval Gun Factory. May '56. 26 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. Price 75¢ (PB 131090)*

Describes two vacuum treating production units that are said to improve the soundness and mechanical properties of nonferrous sand castings and forgings. One can vacuum treat up to 200 lb of aluminum or 600 lb of bronze; the other can treat up to 600 lb of aluminum and 1800 lb of bronze. Outlines advantages, limitations and uses of the two procedures.

Strength of steel STRENGTH AND DUCTILITY OF BAINITIC STEELS. *D. H. Desy, J. O. Brittain and M. Gensamer, Columbia University. Aug '57. 32 pp. Available from National Advisory Committee for Aeronautics, 1512 H St. NW, Wash. 25, D. C. (TN 3989)*

Study of factors believed to affect the strength and ductility of bainitic steels, including mean ferrite path and degree of internal strain. Seven heats of carbon-molybdenum and two heats of carbon steel were transformed isothermally to bainite at various temperatures and tested. Transition temperatures of the bainite fell between -110 and -260 F and did not vary regularly with hardness, carbon or alloy content or mean ferrite path.

Fluorine polymers INVESTIGATION OF CONDENSATION TYPE ELASTOMERS. *G. C. Schweiker, B. S. Marks, R. R. White and R. N. Deleo, Hooker Electrochemical Co. May '57. 55 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. Price $1.50 (PB 131178)*

Compounding studies of an elastomer based on a fluorine-containing polyester. Data indicate that increasing fluorine content decreases the polymer's solubility in common solvents. The data also show that the molecular position of the fluorine affects brittle temperatures.

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THE LAST WORD

by **H. R. Clauser**, *Editor*

After the Ball Is Over

We keep getting calls from people who are making surveys on present and potential uses for titanium. It is no secret that the initial burst of enthusiasm for the "Cinderella metal" has now faded and an earnest search for its best fields of application is now under way. Dr. A. B. Kinzel, vice president for research of Union Carbide Corp. and new president of AIME, recently characterized the present predicament of titanium in this way: "The time is ten past midnight. Cinderella has left the ball after her spectacular debut. She's wretched again—and it may take a few years for the prince to catch up with her."

Jumboizing

We have heard much the last few years about the trend to miniaturization in design. But there are many parts and products in which jumboizing is the trend—for example, construction equipment, particle accelerators, telescopes and the chemise styles the ladies are now wearing. Also we read recently that a shipbuilding concern was jumboizing tankers by slicing them in half and adding a center section. Then, there are still other products in which both trends are combined. Take autos for instance. Their exteriors are being jumboized while their interiors are being miniaturized.

Space Cans

Modern living has conditioned most of us to accepting and even liking canned foods. Now it looks as though the Space Age, which is already here, will condition us to eating the cans as well. Since every ounce of material taken on a space flight must be useful, Albert Olevitch of the Air Materials Lab, Wright Air Development Center, predicts that packages in which food and other supplies will be carried for space travel will probably be made of vitamin-containing chemical films. After use, the containers will be eaten or used as plant food or converted into useful gases.

Instant Plastics

Of course, the unusual problems of space travel, space platforms, and stations on the moon will require many other new materials. For example, there is the problem of transporting bulky, conventional structural materials over vast distances. Perhaps we already have a partial solution to this particular problem in our plastics foams. The basic resins, unfoamed, could be shipped to the space station where they would be foamed-in-place as needed.

Science for What?

Dr. Robert F. Mehl, director of Metals Research, Carnegie Tech, in a recent talk pointed out the "curious dualism" of basic research. It is at once "the pursuit of knowledge for the sake of knowledge alone . . . and one of the most useful [activities] to the ordinary needs of man." In a way it is a sad commentary on our modern culture that these positive values of science are being largely forgotten. Instead, the principal motivation behind the revival of interest in science (and education also) has been fear and the realization that science and knowledge have become tools for power in the struggle for national survival.